

Issues in and Possible Reforms of the U. S. Patent System

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1. Overview

During the first half of this decade, the chorus of critics of the current operation of the U.S. patent system has increased in size, and even included the occasional member of the popular press. The outcry has culminated in a series of reports by governmental and public interest organizations recommending a number of reforms to the system.² Based for the most part on the recommendations in these reports, recently a bill (H. R. 2795) was introduced in the U.S. Congress that would introduce a number of far-reaching

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² In particular, see “To Promote Innovation: The Proper Balance of Patent and Competition Law Policy,” The Federal Trade Commission, October 2003; “A Patent System for the 21st Century,” The National Academies’ Board on Science, Technology, and Economic Policy, 2004; and the Reply to the National Academies Report by the American Intellectual Property Law Association, 2004.

changes to the system if it is passed into legislation. At the present time, hearings related to the proposed changes in the bill have been held in both the Senate and the House, and it has been substantially revised in the various subcommittees, based upon critiques by stakeholders in the system. At the present time it is not clear when and whether and in what form legislation will issue, but that something will come out of the process seems almost certain.

My presentation today discusses the economic rationale for the patent system briefly, reviews the changes to the U. S. patent (and innovation) system that have led to the current situation and the arguments behind the calls for reform. It then discusses in more detail the issues that are under consideration for legislation and the current prospects for that legislation.

2. Patents and innovation

For an economist, the central patent policy question is whether the patent system increases innovative activity on net, recognizing that it has both costs and benefits for this activity.³ In testimony before the FTC/DOJ Hearings on Competition and Intellectual Property Law in the Knowledge-Based Economy, I offered the following simple chart as a framework for thinking about costs and benefits of patents:

³ A secondary question might be whether the patent system increases innovative activity so much that it rises above the social optimum. Most scholars and policy makers seem to agree that this is an unlikely possibility.

Table 1
The Patent System Viewed by a Two-Handed Economist

Effects on:	Benefit	Cost
Innovation	creates an incentive for R&D; promotes the diffusion of ideas	impedes the combination of new ideas & inventions; raises transaction costs
Competition	facilitates entry of new small firms with limited assets; allows trading of inventive knowledge, markets for technology	creates short-term monopolies, which may become long-term in network industries

This chart is intended to suggest that in addition to the familiar arguments that patents increase innovation via incentive effects and diffusion and decrease competition because they create temporary monopolies, there are offsetting effects in both cases that have become more apparent in recent years.⁴ These offsetting effects are the tendency of patents to increase the costs of subsequent innovators, especially when these innovators need to combine inventions from many sources, as well as the fact that patents may help

⁴ This is not to say that these effects have gone completely unrecognized in the past. Consider the following quotation from a sugar manufacturer in Great Britain during the 19th century: “In the manufacture with which I am connected – the sugar trade – there are somewhere like 300 or 400 patents. Now, how are we to know all these 400 patents? How are we to manage continually, in the natural process of making improvements in manufacture, to know which of these patents we are at any time conflicting with? So far as I know, we are not violating any patent; but really, if we are to be exceedingly earnest in the question, probably we would require to have a highly paid clerk in London continually analysing the various patents; and every year, by the multiplication of patents, this difficulty is becoming more formidable.” [Macfie, R.A., quoted in “Is the Granting of Patents for Inventions Conducive to the Interests of Trade?,” Transactions of the National Association for the Promotion of Social Science 661, 665 (1865) (George W. Hastings, ed.)]

competition by facilitating the vertical disintegration of knowledge-intensive industries and helping new entrants.

As the chart illustrates, the body of economic theory that lies behind it yields an inconclusive answer to the question of whether patents encourage innovation generally. We therefore turn to the empirical evidence on this question, which comes in several flavors: survey evidence, cross country studies, and studies within individual patent systems. The conclusions from the empirical studies that I have surveyed in the past are several in number. The first is that introducing or strengthening a patent system (lengthening the term, broadening subject matter coverage, etc.) unambiguously results in an increase in patenting and in the strategic uses of patents (Lerner 2002; Baldwin et al 2000; Hall and Ziedonis 2001).

Second, it is much less clear that these changes result in an increase in innovative activity, although they may redirect such activity toward things that are patentable and/or are not subject to being kept secret within the firm (Moser 2001; Lerner 2002; Baldwin et al 2000). Third, if there is an increase in innovation due to patents, it is likely to be centered in the pharmaceutical and biotechnology areas, and possibly specialty chemicals (Levin et al 1987; Cohen et al 2001; Arora et al 2001).

Fourth and finally, the existence and strength of the patent system DOES affect the organization of industry, by allowing trade in knowledge, which facilitates the vertical disintegration of knowledge-based industries and the entry of new firms that possess only intangible assets (Hall and Ziedonis 2001; Arora et al 2003; Arora and Merges 2004).

Thus the bottom line from the empirical evidence is that the patent system provides clear incentives for innovation in only a few sectors, but that firms and industries do respond to its presence, both by making use of the system and by sometimes tailoring their innovative strategies to its presence. As Edith Penrose said some time ago when speaking to the same question,

“If national patent laws did not exist, it would be difficult to make a conclusive case for introducing them; but the fact that they do exist shifts the burden of proof and it is equally difficult to make a really conclusive case for abolishing them.”⁵

3. Evolution of the U.S. Patent System since 1980

As with (almost) all governmental institutions, the U.S. patent system has evolved and continues to evolve, in ways that are ultimately driven by forces related both to a perception of increased global competition, especially in knowledge-intensive sectors and to technological change itself: the expansion of subject matter coverage, the strengthening of the enforcement system, and the encouragement of patenting by upstream actors can all be seen as driven by these forces.

Unfortunately (from the perspective of optimal policy), many of the changes in patent policy in the United States during the past two decades have been as a result of court decisions, especially those of the Court of Appeals of the Federal Circuit (CAFC), and to a lesser extent by the Supreme Court. Addressed as they are to the features of individual cases, these decisions do not always consider the broader policy implications

⁵ *The Economics of the International Patent System* (1951).

as they set precedents. As a result of a series of court decisions by these bodies, the subject matter eligible for patenting has been extended to new technologies (biotechnology), technologies previously not subject to patent protection (business methods, software), and to upstream scientific research tools, materials, and discoveries (*Madey v. Duke*, 2002). The rights of patent holders vis-à-vis alleged infringers have been strengthened by such decisions as *Polaroid v. Kodak* (1986/1991), which yielded a major damage award to Polaroid and shut down the instant camera business of Kodak.

Of course in many ways these court decisions were the consequence of legislative changes in 1982, during which the CAFC was created, and the position of patent holders strengthened by a number of procedural changes in the courts. In a comparison of appeals cases from 1953 to 1978 and from 1982 to 1990, the share of District Court decisions finding validity and infringement that were upheld by the higher court increased from 62 percent to 90 percent. Decisions of invalidity and no infringement were reversed 12 percent of the time before the Federal Circuit's creation and 18 percent afterward. Moreover, the rate of preliminary injunctions increased dramatically.⁶

The early 1980s was also the period when the well-known Bayh-Dole Act passed into the law, leading to the emergence of new players such as many universities and public research institutions, as well as an increase in activity at institutions that had already been patenting some of their research results.

The 1988 Process Patent Amendments Act enabled U.S. process patent holders to block the import of foreign products produced by methods infringing their patents as well

⁶ See Lerner (1995); Lanjouw and Lerner (1997); Allison and Lemley (1998); and Jaffe (2000).

as to hold domestic sellers or users of a product made by a patented process liable for infringement.

From the 1980s onward there was also a marked evolution in the attitude of the Justice Department's Antitrust Division and the Federal Trade Commission toward business conduct involving patents, resulting in a much more nuanced and pro-patent position (FTC, 2003). In 1981 the division's deputy assistant attorney general abandoned a list of nine licensing practices that the department a decade earlier had characterized as automatically illegal. The 1988 Justice Department Antitrust Enforcement Guidelines for International Operations outlined the consumer benefits from intellectual property licensing and adopted a rule-of-reason approach to such issues. In 1995 the Justice Department and the Federal Trade Commission jointly issued Antitrust Guidelines for the Licensing of Intellectual Property, reiterating the 1988 principles and declaring that "the Agencies do not presume that intellectual property creates market power in the antitrust context" and intellectual property licensing is "generally pro-competitive."

Taken together, these changes all add up to a considerable strengthening of patent holder rights and broadening of the reach of the patent system. As I summarize in the next section, the response to these changes on the part of private firms has been dramatic.

4. Evolution of Patent Strategy in U.S. firms since 1980

The most obvious response to these changes in the patent system was the increase in patenting across many sectors, leading to a doubling of patent applications and grants during the 10 year period between 1992 and 2002. In Hall (2005), I used a simple time series analysis to show that the time series of aggregate patent applications in the US displayed a structural break in 1984, with the annual growth rate increasing from zero to

over six per cent. Such a growth rate will produce a doubling in twelve years. I also showed that most of the growth was due to increased patenting by firms in the information and communication technology (ICT) sectors, which is consistent with the view that much of it is for defensive reasons (Arora et al 2001; Hall and Ziedonis 2001; Hicks et al 2001). At the same time, the contribution of increased university and public research institution patenting to growth was relatively small. From a regional perspective, over half the growth was due to inventors in the United States, one third to those in Asia and the small remainder to inventors in Europe. Thus the growth was driven by the behavior of the ICT sector in the U.S. and Asia.

A number of other behavioral changes have accompanied this increase in patenting: slightly higher renewal rates, more frequent assertion of patents, a doubling of U.S. District Court patent suits, 1988-2001, and some evidence that the probability of a suit per patent has increased recently (Bessen and Meurer 2005). The complexity of patents in terms of number of claims and citations of prior art has grown, and patentees tend to invest more in the process of application and examination. In testimony before Congress, the current Director of the USPTO, Jon Dudas, reported that more than 100,000 of the 355,000 patent applications filed in 2004 were continuations of applications that had been previously reviewed by an examiner. He also reports on the problem of “super-sized” applications submitted by a minority of applicants (7 per cent of the applications account for 25 per cent of the claims examined; some are submitted on CD-ROMs with thousands of claims).

In addition, many critics have argued that the sheer volume of patent applications threatens to degrade the quality of issued patents or lengthen the backlog or both. On the

backlog there is no doubt. In April 2005, Dudas reported that pendency in data-processing technologies stood at three years and growing, and that without intervention, the current backlog of applications awaiting first review could double from 500,000 to a million in the next 5 years.

Finding hard evidence of a decline in quality is more difficult, although a number of legal scholars and practitioners have been vocal on the subject, sometimes not for quotation. There are several reasons to believe that quality (especially the application of the nonobviousness criterion of patentability) has suffered as the number of applications has grown. First, the number of patent examiners has not kept pace with the increase in workload represented by the increased number and growing complexity of the applications. Second, there does seem to have been a dilution of the application of the nonobviousness standard in biotechnology (due to court decisions) and some limitations on applying it properly to business method patent applications, among other reasons being the absence of adequate written prior art documents.

Third, patent approval rates at the USPTO are higher than in some other major nations' patent offices (notably the EPO), even before adjusting for the impact of the continuation process (which makes the ultimate grant rate for any given application higher). Finally, some changes in the treatment of genomic and business methods application were introduced (the second pair of eyes for business methods patents and the requirement of a specific application or use of a new gene sequence) that resulted in a slowing down of patent grants in those fields, suggesting that the previous bar may have been set too low.

During the FTC/DOJ hearings on the patent system and antitrust policy in 2002, a number of industry representatives expressed concerns about the difficulty of negotiating the patent thicket in their area and the risk of being “held-up” ex post by a patent on a technology that was only a small component of their product. This complaint was heard largely from those in the complex product industries (the ICT sector), such as Robert Barr, then Vice-President for Intellectual Property and Worldwide Patent Counsel at Cisco Corporation. He described two types of problems faced by firms in the sector: the first being the large stockpiling of patents necessary as a defensive measure against others in the industry and the second being the threat posed by small entities that have nothing at risk themselves and may not even be producers. On the first, Barr says the following:

“My observation is that patents have not been a positive force in stimulating innovation at Cisco. Everything we have done to create new products would have been done even if we could not obtain patents on the innovations and inventions contained in these products.The only practical response to this problem of unintentional and sometimes unavoidable patent infringement is to file hundreds of patents each year ourselves, so that we can have something to bring to the table in cross-licensing negotiations.The time and money we spend on patent filings, prosecution, and maintenance, litigation

and licensing could be better spent on product development and research leading to more innovation.”⁷

On the second problem (that of being attacked ex post by a small entity that does not face much risk of infringement itself):

“.....stockpiling patents does not really solve the problem of unintentional patent infringement through independent development. If we are accused of infringement by a patent holder who does not make and sell products, or who sells in much smaller volume than we do, our patents do not have sufficient value to the other party to deter a lawsuit or reduce the amount of money demanded by the other company.”

The first of the problems Barr describes is clearly a case of mutually assured destruction that leaves the firms in question no better off than if they were not accumulating massive numbers of patents for defensive purposes, and yet at the same time is a very costly strategy. Increasing the administrative costs of patents to firms or reforms within the industry itself to discourage this behavior would seem to be the obvious solution, since it would be in the interest of all firms involved to reduce spending on this activity. However, the second problem is more controversial: the small entities that assert patents in this way may have legitimate claims to ownership of some of the technology in a large firm’s product. Some observers have even questioned how common

⁷ That this is not just the belief of one representative of one company is confirmed by the interview evidence obtained by Rosemarie Ziedonis and myself from several semiconductor firm representatives, as well as by our subsequent econometric work (Ziedonis and Hall 2001).

this kind of patent assertion is.⁸ Nevertheless, the IT industry in general has been very concerned about these kinds of assertions and their consequences for the incentives to invest in complex technologies that might potentially incorporate a piece of technology which leads to a dispute that cannot be resolved by cross-licensing.

The final area where change in patenting practice and IP management has raised concern in policy circles is the increased patenting of “research tools” and its consequences. Walsh et al (2003) interviewed some 70 players in the biotechnology research area and found that by and large intellectual property in biotechnology is being managed relatively successfully. Because of increasing patent assertion and the extension of patentability to life forms and gene sequences, the associated costs of research are somewhat higher and research can sometimes be slowed, but it is rarely blocked altogether. There are, however, occasional cases of restricted access to foundational discoveries and to some diagnostic genetic tests. A number of “working solutions” have evolved, including negotiated licenses and royalty payments. Patents are also circumvented by inventing around them, using substitute research tools, and locating research activity offshore. Institutional responses include the National Institutes of Health guidelines encouraging research grantees to facilitate access to patented research tools and the steps taken by several research organizations to place results in the public domain, where they become patent-defeating prior art.

⁸ For example, in well-publicized testimony, Nathan Myrhvold of Intellectual Ventures and former CTO of Microsoft has critiqued the idea that patent litigation is increasing or indeed is an important problem. Because Myrhvold has not yet released the study on which these claims are based, it is difficult to know how his numbers compare to those in several published studies, or indeed how they were obtained.

5. The patent reform bill and its current prospects

During the past year and partly in response to the NAS and FTC reports as well as the position taken by the AIPLA, Congress has shown considerable interest in patent reform. Several hearings presided over by Senator Orrin Hatch (R-UT) have been held in the Senate and in June 2005, Representative Lamar Smith (R-TX) introduced a Patent Reform Bill (H.R. 2795) in the House and held a subcommittee hearing on June 9, 2005. Based on testimony and the input received from various stakeholders, Smith published a substitute bill and held hearings on it in September 2005. A summary list of hearings held is shown in Table 2.

A number of interested groups have thrown their support behind the principle of patent reform, although they do not necessarily agree on all the individual items in the proposed bill. These groups are the AIPLA, the Intellectual Property Owners Association (IPO), the IP Law section of the American Bar Association, the Biotechnology Industry Organization (BIO), and the Business Software Alliance (BSA). A coalition formed by 37 large patentholding firms (9 chemical, 16 pharmaceutical and 12 in a number of other sectors), the AIPLA, and the IPO has presented a reform package that is similar to but not identical to the substitute H.R. 2795 bill published by Smith in September.

Table 2
Summary of Hearings on Patent Reform, 109th U. S. Congress

Date	Committee	Topic
25 April 2005	Senate Judiciary, Subcommittee on IP	The Patent System Today and Tomorrow
7 June 2005	Senate Judiciary, Subcommittee on IP	Patent Law Reform: Injunctions and Damages
9 June 2005	House Judiciary, Subcommittee on Courts, the Internet, and IP	H.R. 2795, the "Patent Act of 2005"
14 July 2005	Senate Judiciary, Subcommittee on IP	Perspectives on Patents: Harmonization and Other Matters
15 Sept. 2005	Senate Judiciary, Subcommittee on IP	Amendment in the nature of a substitute to H.R. 2795, the "Patent Act of 2005"

The original H. R. 2795 bill contained the following provisions:

1. Changes the current "first to invent" standard to "first inventor to file" (§3). This is an important step in achieving international harmonization and was accompanied by a rewrite of the prior art rules that has caused some controversy in the legal profession but is a necessary part of harmonization. Accompanying this change was the preservation of a one year grace period after publication, intended to benefit small inventors and university researchers. Also accompanying it was an extension of prior user rights to all U.S. manufacturers of all inventions to protect those who use trade secrecy instead of the patent system. These changes are in the revised bills.

2. Eliminates the subjective "best mode" requirement from §112 of the Patent Act, delineating objective criteria that an inventor must set forth in an application (§4). This change also represents a move toward harmonization. It remains in the revised bill.

3. Imposes a duty of candor and good faith on parties to contested cases before the patent office, eliminating inequitable conduct as a defense of patent unenforceability (§5), unless at least one claim in the patent has already been found invalid.
4. Reduces the scope of willful infringement by raising the standard of proof required, and limits the amount of damages a patentholder can collect from an infringer (§6).
The substitute bill of Smith and the coalition reform package both change the wording but still try to limit the situations where treble damages can be assessed to cases where notice of infringement has clearly been given by the patentholder.
5. Limits patentees' ability to obtain injunctions (§7). This has proved very controversial and has been removed from the substitute bill and coalition reform package.
6. Authorizes the director of the patent office to regulate continuation applications (§8).
Again, this is controversial and has been removed.
7. Establishes a new post-grant opposition system in the patent office (§9) with a 9 month window. A second window of 6 months at the time of litigation has since been removed, but of course re-examination could still be requested. The substitute bills contain changes intended to increase the take up of *inter partes* re-examination.
8. Allows members of the public to introduce new information to the patent office up to six months after the date of publication of the patent application to challenge the patent and to provide a final quality check (§10).

As indicated above, in committee a number of these provisions have been dropped or weakened, largely due to opposition from the pharmaceutical and biotechnology sector, but also from a number of large chemical firms, 3M, General

Electric and large companies in traditional technologies who are more or less satisfied with the current system. The provision that allows the patent office to restrict continuations has been removed because of biotechnology industry opposition; this industry has been and continues to be a heavy user of continuations (Graham 2002).

An interesting recent development on the continuation issue has come from the USPTO itself in the form of a set of proposed rule changes and request for comment in the Federal Register of January 3, 2006. As was clear from the Dudas testimony cited earlier, continuations have become of major concern to the office because they take examiner time away from new applications, and often require reconsideration of material that has already been examined. Therefore they are proposing that all continuations (including continuations-in-part and divisionals) other than the first be accompanied by a “showing as to why the amendment, argument, or evidence presented could not have been previously submitted.”⁹ The deadline for comments on this rule change is the 3rd of May. It is not immediately clear that the change will have the desired effect, since it appears to call for even more documentation to be submitted with each continuation; presumably they are hoping that the requirement will reduce the actual number of continuations by sending a clear message to potential applicants.

The concerns of the computing sector lie in other areas. Apparently the BSA (representing Intel, Microsoft, and other big software producers) were strongly in favor of three “reforms” -- a second window on opposition, no automatic injunctions where infringement is found, and that infringement damage calculations should be based on the contribution of the patented technology to the value of the product. They backed down on

⁹ U. S. Federal Register 71 (1): 48-63.

the first in the face of fierce pharmaceutical opposition. The second (and possibly the third) has been taken up by the Supreme Court when it granted *certiorari* in the *eBay/Merc-Exchange* case, although the outcome of that case is not yet known.¹⁰

What effect that will have on legislation in this coming session is unclear, and the opposing sides appear not to have reached agreement on the question of either injunctions or damages when the patented technology is a small piece of the product. For reasons which are not entirely obvious, the pharmaceutical industry has been very opposed to changes in this area, whereas the computer hardware and software sectors are strongly in favor. Most observers (e.g., see Mark Lemley's testimony to the Senate subcommittee on June 7, 2005) would argue that the two sectors (pharmaceutical/biotechnology/medical devices on the one hand and information and communication technologies on the other) use the patent system in very different ways and face very different problems of enforcement and litigation, because of the nature of their products and the technologies they involve. Apparently the pharma sector is reluctant to change a system that they perceive is working to their benefit, especially in directions that might weaken it, even though some of the proposed changes would have little impact on those whose products are not based on complex technologies where a patent on a very small piece of the product can wield disproportionate power.

With respect to injunctions, the concern of upstream research entities such as the Wisconsin Alumni Research Foundation (WARF) is easy to understand. The wording in the bill appears to require injury to the patentholder from absence of an injunction, which

¹⁰ The patents in question in this case are also being re-examined at the USPTO and the final decision on their validity has not yet been reached.

sounds like a patent “working” requirement. This requirement is likely to be difficult for universities and public research institutions to meet and they are therefore opposed to any change in this area. On the other hand, such a provision is clearly targeted to the damage done by so-called “patent trolls.” These are entities who are able to hold firms up for much larger sums than they would ordinarily receive in the form of licensing revenue because they have the capability to shut down an entire product line via injunction, even though their piece of the technology in the product might be very small.

In any case, many think a bill of some sort will pass in the next Congress, given the interest that has been raised by the hearings and the known problems in the patent system. However, it is known that the current House Judiciary Chair, James Sensenbrenner (R-Wisconsin) is sensitive to the concerns of WARF, which are similar to those of the pharma/biotech sector, whereas Smith (who introduced the bill) is possibly more attuned to the problems of the ICT sector in his home state of Texas. Because the Committee Chair is in a position to stop the bill from exiting committee if he or she does not like it, there is some incentive for delay on the part of those who would like to introduce changes in the use of injunctions and the apportionment of damages until the current Chair is replaced.

References

- Allison, J., and M. Lemley. 1998. "Empirical Evidence on the Validity of Litigated Patents." *AIPLA Quarterly Journal* 26:185-277.
- American Intellectual Property Law Association. 2004. Reply to the National Academies Report, Washington, DC.
- Arora, A., and R. P. Merges. 2004. "Specialized Supply Firms, Property Rights, and Firm Boundaries," *Industrial and Corporate Change* 13 (3): 451-476.
- Arora, A., A. Fosfuri, and A. Gambardella. 2003. "Markets for Technology and Corporate Strategy," in O. Granstrand (ed.), *Economics, Law, and Intellectual Property*, Boston/Dordrecht/London: Kluwer Academic Publishers.
- Arora, A., M. Ceccagnoli, and W. Cohen. 2001. "R&D and the Patent Premium," Carnegie-Mellon University and INSEAD: paper presented at the ASSA Annual Meetings, January 2002, Atlanta Georgia.
- Baldwin, J. R., P. Hanl, and D. Sabourin. 2000. "Determinants of Innovative Activity in Canadian Manufacturing Firms: The Role of Intellectual Property Rights" Statistics Canada Working Paper No. 122 (March).
- Bessen, J., and M. J. Meurer. 2005. "The Patent Litigation Explosion," Research on Innovation and Boston University School of Law: manuscript (August).
- Cohen, W. M., R. R. Nelson, and J. P. Walsh. 2001. "Protecting Their Intellectual Assets: Appropriability Conditions and Why Firms Patent or Not?" NBER Working Paper No. 7552.
- Dudas, J. 2005. "Statement of the Honorable Jon W. Dudas Deputy Under Secretary of Commerce for Intellectual Property and Director of the US Patent and Trademark Office before the Subcommittee on Intellectual Property, Committee on the Judiciary," US Senate. <http://judiciary.senate.gov>
- Federal Trade Commission. 2003. "To Promote Innovation: The Proper Balance of Patent and Competition Law Policy," Washington, DC: GPO, October.
- Hall, B. H. 2005. "Exploring the Patent Explosion," *Journal of Technology Transfer* 30: 35-48.
- Hall, B. H., and R. H. Ziedonis. 2001. "The Patent Paradox Revisited: An Empirical Study of Patenting in the U.S. Semiconductor Industry, 1979-1995," *Rand Journal of Economics* 32:101-128.
- Hicks, D., T. Breitzman, D. Olivastro, and K. Hamilton. 2001. "The Changing Composition of Innovative Activity in the US—A Portrait Based on Patent Analysis." *Research Policy* 30(4):681-704.
- Jaffe, A. 2000. "The U.S. Patent System in Transition: Policy Innovation and the Innovation Process." *Research Policy* 29:531-557.

- Kortum, S., and J. Lerner. 1999. "What is Behind the Recent Surge in Patenting?" *Research Policy* 28: 1-22.
- Lanjouw, J. O., and J. Lerner 1997. "The Enforcement of Intellectual Property Rights: A Survey of the Empirical Literature," NBER Working Paper No. W6296. Available at <http://ssrn.com/abstract=226053>.
- Lanjouw, J. O., and I. Cockburn. 2000. "Do Patents Matter? Empirical Evidence after GATT," NBER Working Paper No. 7495.
- Lerner, J. 1995. "Patenting in the Shadow of Competitors," *Journal of Law and Economics* 38 (Oct.):463-495.
- Lerner, J. 2002. "Patent Policy Shifts and Innovation over 150 Years," *American Economic Review P&P* (May).
- Levin, R. C., A. K. Klevorick, R. R. Nelson, and S. G. Winter. 1987. "Appropriating the Returns to Industrial R&D," *Brookings Papers on Economic Activity*: 783-820.
- Mansfield, E. 1986. "Patents and Innovation: An Empirical Study," *Management Science* 32: 173-81.
- Merges, R., and R. R. Nelson. 1990. "On the Complex Economics of Patent Scope," *Columbia Law Review* 90: 839-916.
- Moser, P. 2001. "How do Patent Laws Influence Innovation? Evidence from Nineteenth Century World Fairs." UC Berkeley: working paper.
- National Research Council. 2004. *A Patent System for the 21st Century*, Report of the Board on Science, Technology, and Economic Policy, National Academies Press, Washington, DC.
- Park, W. G., and J. C. Ginarte. 1997. "Intellectual Property Rights and Economic Growth," *Contemporary Economic Policy* XV (July): 51-61.
- Penrose, E. 1951. *The Economics of the International Patent System*, Baltimore: John Hopkins University Press.
- Sakakibara, M., and L. Branstetter. 2001. "Do Stronger Patents Induce More Innovation? Evidence from the 1988 Japanese Patent Law Reforms," *Rand Journal of Economics* 32: 77-100.
- Walsh, J., A. Arora, and W. Cohen. 2003. "Research Tool Patent and Licensing and Biomedical Innovation." In *Patents in the Knowledge-Based Economy*, W. Cohen and S. Merrill, eds. Washington, D.C.: National Academies Press.
- Ziedonis, R. H. and B. H. Hall. 2001. "The Effects of Strengthening Patent Rights on Firms Engaged in Cumulative Innovation: Insights from the Semiconductor Industry," in Libecap, Gary (ed.), *Entrepreneurial Inputs and Outcomes: New Studies of Entrepreneurship in the United States*, Vol. 13 of *Advances in the Study of Entrepreneurship, Innovation, and Economic Growth*, Amsterdam: Elsevier Science.