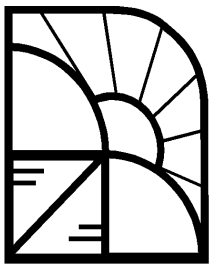

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*Phoenix Center Policy Paper Number 30:*

# *Quantifying the Cost of Substandard Patents:*

# *Some Preliminary Evidence*

George S. Ford, PhD
Thomas M. Koutsky, Esq.
Lawrence J. Spiwak, Esq.

(September 2007)

# Phoenix Center Policy Paper No. 30
## *Quantifying the Cost of Substandard Patents: Some Preliminary Evidence*

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*Abstract:* The purpose of patent policy is to balance the incentive to invent against the ability of the economy to utilize and incorporate new inventions and innovations. Substandard patents that upset this balance impose deadweight losses and other costs on the economy. In this POLICY PAPER, we examine some of the deadweight losses that result from granting substandard patents in the United States. Under plausible assumptions, we find that the economic losses resulting from the grant of substandard patents can reach $21 billion per year by deterring valid research with an additional deadweight loss from litigation and administrative costs of $4.5 billion annually. This brings the total deadweight loss created by our "dented" patent system to be at least $25.5 billion annually. These estimates may be viewed as conservative because they do not take into account other economic costs from our existing patent system, such as the consumer welfare losses from granting monopoly rents to patent holders that have not, in the end, invented a novel product, or the full social value of the innovations lost.

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‡ President, Phoenix Center for Advanced Legal & Economic Public Policy Studies. The views expressed in this paper are the authors' alone and do not represent the views of the Phoenix Center, its Adjunct Fellows, or any of its individual Editorial Advisory Board members. We are indebted to Randy Beard, Adjunct Fellow, for his assistance in formulating the economic model presented in this paper.

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## I. Introduction

Patent policy necessarily involves a balance between encouraging inventors to create new products while simultaneously ensuring that innovations become diffused throughout the economy. Protecting intellectual property is a lynchpin of a vibrant, modern economy, and while the benefits of the patent system are undeniable, the system also imposes significant cost on the economy—even in the best of circumstances. Several high-profile patent disputes, such as the Blackberry and Microsoft MP3 cases, have sparked a debate as to whether the United States patent law system adequately promotes the interests of inventors or whether the system is a legal quagmire that stalls new innovation in excessive litigation.[1] When a patent system grants substandard patents or provides overly-permissive legal remedies for patent holders, the protection of intellectual property can create substantial net loss of economic welfare. So, while a well-functioning patent system must balance the benefits of innovation with the costs of monopoly, a defective system adds to the costs of patent monopolies additional deadweight losses from reduced innovation and from the wasted resources directed at securing and protecting substandard patents, without providing any offsetting benefit.

[1] For a summary of the ills of the modern patent system and critiques against it, *see* A. Jaffe and J. Lerner, INNOVATION AND ITS DISCONTENTS: HOW OUR BROKEN PATENT SYSTEM IS ENDANGERING INNOVATION AND PROGRESS, AND WHAT TO DO ABOUT IT (2004). As the National Research Council of the National Academies noted, "patents on trivial innovations may confer market power or allow firms to use legal resources aggressively as a competitive weapon without consumer benefit." Nat'l Research Council of the Nat'l Acads., A PATENT SYSTEM FOR THE 21ST CENTURY (2004).

The economic costs of substandard patents are highlighted by (but by no means limited to) "patent troll" litigation, to which a substandard patent regime can give rise. "Patent troll" litigation is perhaps best thought of as a form of litigation arbitrage—it will exist in areas in which patents are relatively easy to obtain and the consequences to a defendant accused of infringement of losing a patent suit can be enormous and irreversible, such as an injunction against any future sales of a successful yet potentially-infringing product. The presence of this arbitrage indicates that the current patent licensing and enforcement system are in need of reform and a thoughtful rebalancing of incentives.

In this POLICY PAPER, we attempt to quantify in a preliminary manner a portion of the cost to the United States economy of substandard patents granted by the United States Patent and Trademark Office ("USPTO"). In particular, we focus upon deadweight losses that result from the impact that a "loose" patent system that unduly grants "substandard" patents has upon innovation and the development of important, valid patents. These costs are deadweight losses and not merely transfers, so they reduce overall economic welfare. We estimate that the deadweight loss of a "loose" patent system from lost innovation is approximately $21 billion each year in private costs alone, or nearly $200 per household per year. This sizeable deadweight loss constitutes approximately 7% of annual R&D spending in the United States. Deadweight losses from litigation and administrative costs from substandard patents constitute an additional $4.5 billion annually, or 1.5% of the country's annual R&D spending.

Our findings are described as preliminary, since there is very limited data upon which to base our estimates. However, we believe our methods render conservative estimates because we do not take into account a number of other costs created by substandard patents. Most notably, in cases where a substandard patent allows a firm to enforce monopoly prices without truly innovating, there is a welfare loss without commensurate benefit that our model does not attempt to quantify. We also ignore the fact that innovation has a greater social benefit than private benefit, so the social costs of lost innovation stand to be much larger than the $21 billion in annual private costs from lost innovation that we estimate.[2]

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[2] *See, e.g.,* A. Jaffe, *Economic Analysis of Research Spillovers Implications for the Advanced Technology Program*, National Bureau of Economic Research, Advanced Technology Program (1996); C. Jones and J. Williams, *Measuring the Social Return to R & D*, 113 THE QUARTERLY JOURNAL OF ECONOMICS 1119 (1998).

The POLICY PAPER is organized as follows. In Section II, we provide a brief description of the general problem of substandard patents and their causes and consequences. Our discussion is succinct, since there are many studies on this issue that are readily available to interested parties. In Section III, we explain an important component of our model, which focuses on the important interactions between the equilibrium level of "valid" and "substandard" patents. We show that substandard patents impose deadweight losses on the economy as a whole because they deter innovation and the development of important, valid patents. This idea serves as the basis for the estimation that we perform in Section IV. Section IV also contains a sensitivity analysis to allow the inputs to vary over the range of plausible values. Our conclusions and findings are summarized in the final section.

## II. Sources and Costs of a "Loose" Patent System

A well-functioning patent system engages in a delicate balance. In order to "promote the progress of Science and useful Arts,"[3] a patent holder is granted a legal exclusive monopoly to an invention for a limited period of time. It is thought that granting monopoly profits to patent holders would direct societal resources towards scientific and useful innovations. Thomas Jefferson once wrote that patent law is about "drawing a line between the things which are worth to the public the embarrassment of an exclusive patent and those which are not."[4]

What Jefferson calls the "embarrassment" of a legal patent monopoly, economists would call a social cost. By definition, the granting of a monopoly reduces output and causes a net loss in consumer welfare. The traditional justification for patent rights is predicated upon the assumption that without such monopoly rights, society will not achieve the optimal rate of innovation because innovations and scientific discoveries are, absent patent rights, often public goods that provide limited or no opportunity for the inventor to recover the costs of discovery. If every invention could be immediately copied, then few firms would invest the resources to invent new products. Absent patent rights, an inventor also would have an incentive to prevent others from learning about

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[3] U.S. Const., art. 1, sec. 8.

[4] *Bonito Boats, Inc.* v. *Thunder Craft Boats, Inc.*, 489 U.S. 141, 148 (1989) (*citing* 13 WRITINGS OF THOMAS JEFFERSON 335 (Memorial ed. 1904)).

any new discovery.[5] A patent attempts to remedy these problems by giving the inventor the legal right to collect some portion of the social value attributable to the invention while inducing disclosure of the details of the invention to the public.[6] This disclosure, in turn, likely increases innovative activity in that area due to increased information.[7]

At the same time, granting too much protection to inventors (or granting it too easily) can hamper the creation and diffusion of technology throughout the economy. Achieving an adequate balance of rights to compensate true innovators and foster the use of patented technology is the goal of a well-functioning patent system. A patent regime that makes it too easy to obtain and enforce a patent could create too many of these monopoly "embarrassments" that would reduce economic welfare by virtue of their monopoly status yet not promote economic welfare because they do not reward true innovations.[8] As the Supreme Court stated in 1950, the granting of patents for obvious and known methods "withdraws what is already known into the field of its monopoly and diminishes the resources available to skillful men."[9]

There are several ways in which a substandard patent system can impose economic and welfare costs on the economy. As we describe in Section III below, a "loose" patent system causes deadweight economic losses because the presence of substandard patents diminish the overall level of innovation and development of valid patents. These deadweight losses cause resources to be allocated inefficiently and therefore affect the entire economy. In addition, a "loose" patent system that grants large numbers of substandard patents also causes a

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5 K. W. Dam, *The Economic Underpinnings of Patent Law,* 23 J. LEGAL STUD. 247, 247-48 (1994).

6 Kitch adds that patents also promote efficiency by deterring others from engaging in wastefully duplicative efforts of re-inventing the same technology. E. W. Kitch, *The Nature and Function of the Patent System,* 20 J. L. & ECON. 265 (1977); *see also* Dam, *supra* n. 5 at 266-67.

7 There is some dispute regarding the value of disclosure. *See, e.g.*, Y. Spiegel and R. Aoki, *Public Disclosure of Patent Applications, R&D, and Welfare*, Berglas School of Economics Working Paper 30-98 (1998).

8 *See* H. T. Gallini, *The Economics of Patents: Lessons from Recent U.S. Patent Reform,* 17 J. ECON. PERSPECTIVES 131 (2002); B.H. Hall and R.H. Ziedonis, *The Patent Paradox Revisited: An Empirical Study of Patenting in the US Semiconductor Industry, 1979-95,* 32 RAND JOURNAL OF ECONOMICS, 101 (2001) (patenting may be socially wasteful and accumulation of patents may redirect resources away from productive research).

9 *Great Atlantic & Pacific Tea Co., v. Supermarket Equipment Corp.,* 340 U.S. 147, 152 (1950).

number of other inefficiencies and misallocation of resources, as such a system would:

- Cause consumers to absorb monopoly prices over "inventions" that were already effectively common knowledge;[10]
- Direct resources away from productive research and instead towards strategic accumulation of patents already filed over innovations already deployed;[11]
- Divert resources to "defensive patenting" or securing offensive "blocking patents;"[12]
- Direct research away from areas of existing patents that should not have been granted;[13] and
- Direct resources toward acquiring and enforcing substandard patents and collecting royalties rather than other more-productive fields of economic activity.

Given this potential for misallocating resources and other costs, a well-functioning patent law regime should tailor the scope of the legal patent monopolies so that the harms described above are outweighed by the benefit to society from the economic innovation which results from those patent monopolies. As stated by Lévêque and Ménière (2004), the "simple criterion" of economic welfare "helps define the elements of an optimal patent."[14]

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10 "This deadweight loss reduces the total surplus created by the innovation at least during the lifetime of the patent." F. Lévêque and Y. Ménière, THE ECONOMICS OF PATENTS AND COPYRIGHT (2004) at 21.

11 Jaffe and Lerner, *supra* n. 1 at 145-47, describe a number of such activities including the sealed crustless sandwich (at 32) and the perpetual option pricing formula of Vergil Daughtery.

12 Gallini, *supra* n. 8 (describing strategic practice of "defensive patenting"); R. Merges, *Intellectual Property Rights and Bargaining Breakdown: The Case of Blocking Patents,* 62 TENN. L. REV. 75 (1994) (describing the similar strategic use of "blocking patents").

13 Gallini, *supra* n. 8.

14 Lévêque and Ménière, *supra* n. 10.

Whether the United States patent system is "too loose" today is the subject of substantial debate. The claimed shortcomings of the USPTO and the United States court system are numerous and appear to stem primarily from a poor legal framework and an understaffed and overworked agency. The debate often centers around the patenting of "inventions" such as a method for swinging on a swing, the sealed crustless sandwich, a financial technique developed four decades prior to patenting by academics unaffiliated with the patentee, and anti-gravity flying machines.[15] The United States court system, in many ways, exacerbates the problem, brought to light by the explosion of "patent troll" litigation. As observed by Magliocca (2007), patent trolls engage in a very specific arbitrage opportunity and thrive in certain conditions in which patents are easy to obtain and keep, the cost of defending a patent suit are great, and the risk to a defendant of losing a patent suit are enormous because the defendant "cannot easily substitute away from the disputed technology."[16] Trolls thrive in situations in which patents are easy to get and damages uncertain.[17] As Justice Kennedy observed in the *eBay* decision, a patent remedy such as a permanent injunction against an infringer "can be employed as a bargaining tool to charge exorbitant fees to companies that seek to buy licenses to practice the patent."[18]

As a result, almost unique among industrialized nations, United States companies face a plethora of patent suits brought by plaintiffs with arguably

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15 Jaffe and Lerner, *supra* n. 1; *see also* U.S. Patent No. 6,960,975 (granting patent for a "space vehicle propelled by the pressure of inflationary vacuum …").

16 G. N. Magliocca, *Blackberries and Barnyards: Patent Trolls and the Perils of Innovation,* NOTRE DAME L. REV., forthcoming (2007) (available at: http://ssrn.com/abstract=921252).

17 Some commentators argue that "patent trolls" serve a useful purpose, most notably by providing liquidity to inventors as well as expertise in policing infringement. *See, e.g.,* S. Rubin, *Hooray for the Patent Troll*, IEEE SPECTRUM ONLINE (May 2007) ("patent-holding companies provide another way, and sometimes the only way, for an inventor to monetize his patent. They foster innovation by making it possible for small companies and individual inventors to spend their time in research and development, knowing that if a patent does issue, they will not necessarily have to commercialize or litigate it. They can spend time doing what they are good at—inventing"); Z. Roth, *Patent Troll Menace*, WASHINGTON MONTHLY (June 2005) ("The reason this business is attractive to people such as Lockwood is simple: Trolling makes money. . . . [E]ven though his patent was overturned, Lockwood still got to keep the licensing fees he had extracted from other targets that chose not to fight.").

18 *eBay, Inc. v. MercExchange,* 126 S. Ct. 1837, 1842 (2006) (Kennedy, J., concurring).

substandard patents.[19] There are some signs that reform is brewing. Several recent Supreme Court decisions have have addressed the standards for granting and challenging a patent[20] and trimmed back lower court rulings that had increased the business risk and harm from losing a patent lawsuit.[21] The Patent Reform Act of 2007 (H.R. 1908/S. 1145), directed at improving patent quality and changing patent remedies, has been approved by the House and Senate Judiciary Committees. Analyzing and understanding the economic welfare costs of the current United States patent system is clearly of importance to policymakers as they consider these reform proposals.

The welfare costs of the current United States patent regime can be estimated empirically by comparing the valid patent output of our regime to the patent system in Europe. In contrast to the United States, the European patent system, while certainly not perfect, has a relatively "tighter" standard for granting patents and the process is administered and enforced differently as well. By this discussion we do not mean to imply that the European patent system is better than the United States system or that it should be adopted here, we only mean to assert that the two legal regimes are different in a way that allows us to perform an empirical analysis of the current United States patent regime.

To obtain a patent in the United States, the invention must be new, useful and non-obvious.[22] In the United States, unlike some other countries, the process for granting a patent is usually confidential and solely between the applicant and the USPTO, and other parties are not permitted to intervene or oppose a patent

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19 *See, e.g.,* J. Brennan, H. Hsueh, M. Sahashi and Y. Ohkuma, *Patent Trolls in the U.S., Japan, Taiwan and Europe*, 13 CASRIP NEWSLETTER - SPRING/SUMMER (2006).

20 In *KSR International Co. v. Teleflex Inc.,* 127 S.Ct. 1727 (2007) the Court tightened the Federal Circuit's test for patentability, in particular the "obvious" standard. In *MedImmune, Inc. v. Genentech, Inc.,* 127 S.Ct. 764 (2007), the Court overturned a Federal Circuit rule that limited the ability of patent licensees to subsequently challenge the validity of a patent.

21 In *Microsoft Corp. v. AT&T Corp*., 127 S.Ct. 1746 (2007), the Court overturned a Federal Circuit ruling that held Microsoft liable for computers manufactured and programmed abroad with software that infringed a United States patent. In *eBay, supra* n. 18, the Court ruled that traditional equitable principles should apply in patent disputes with regard to the granting of injunctions against infringing products; prior to that decision, lower courts had followed a "general rule" of always issuing such an injunction without considering the public interest.

22 35 U.S.C. §§ 101 ("new and useful"), 103 (non-obvious). For a recent Supreme Court discussion of the obviousness test, *see generally KSR*, *supra* n. 20.

application.[23] Moreover, the USPTO cannot simply reject a patent application, it also bears the burden of making a *prima facie* case that explains the reasons for rejection. Third parties do not have the right to participate in the patent application process and patents can only be challenged after a grant in limited instances, consisting of challenges based on prior art found in patents or printed publications.[24] Moreover, in some instances challenging a patent creates potential for the challenger to be estopped from asserting certain defenses in an infringement suit.[25] Finally, in a suit for patent infringement, a plaintiff may obtain injunctive relief and damages, which may include lost profits due to the infringement or a reasonable royalty.[26]

Pursuant to the European Patent Convention, which harmonizes the patent laws of its signatories, twenty-year patents are available for "any inventions susceptible of industrial application, which are new and which involve an inventive step."[27] The standard for patentability in Europe, while similar to the United States in some respects,[28] is different in other respects, particularly with regard to the European requirement that an invention be of a "technical" nature.[29] In addition, patent applications in Europe are made public even if they

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[23] Patent applications in the United States are not necessarily made public until after a patent is issued. 35 U.S.C. § 122(a). Upon issuances of a patent have a term of twenty years from the date on which the application was filed, but only upon issuance of a patent does the information disclosed in the application becomes a matter of public record. 35 U.S.C. § 154(a). Until 1995 the term of a patent was seventeen years from the date of issuance. 35 U.S.C. § 154(a) (1988) (amended 1994).

[24] 35 U.S.C. §§ 301, 302, 311.

[25] 35 U.S.C. § 315(c).

[26] D. S. Chisum, CHISUM ON PATENTS ¶ 20.01, ¶ 20.03 (1997).

[27] European Patent Convention § 52(1) (1992) (originally enacted Oct. 5, 1973) (available at http://www.european-patent-office.org/legal/epc/index.html).

[28] *Software Patent Law: United States and Europe Compared*, 2003 Duke L. & Tech. Rev. 0006 (2003) (available at: http://www.law.duke.edu/journals/dltr/articles/pdf/2003DLTR0006.pdf) at 3 (comparing U.S. "novelty" step to European "new" step).

[29] European Patent Convention, *supra* n. 28 at §§ 29(1), 52(2). This "technical nature" requirement has led to different approaches in the United States and Europe over the patentability of software and "business method" patents. The European standard does permit the patenting of software directed at a technical process or that contains non-technical features. *See, e.g., In re Sohei,* 1995 O.J.E.P.O. 525 (Tech. Bd. App. 1994) (available at: http://legal.european-patent-office.org/dg3/biblio/t920769ep1.htm).

have not been issued and the method for challenging a patent differ. As a result, a patent application in Europe is three times more likely to be opposed than a patent is to be reexamined in the United States.[30] Of all the potential remedies to the United States patent system, remedying post-grant review process to adopt an approach more consistent with the EPO is by far the most commonly mentioned.[31]

Remedies for patent infringement are also different between the United States and Europe, and these differences appear to encourage more litigation in the United States. In particular, European law tends to favor payment of license fees and damages instead of injunctions over the future sale of infringing products, which have been more common in the United States. For example, in the United States, patent holders do not have a duty to license and their licensing actions are limited only by antitrust law,[32] but in the United Kingdom, France and Germany, compulsory license statutes require patent holders to license their products.[33] While the Supreme Court in 2006 took action to limit the scope of

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[30] Lévêque and Ménière, *supra* n.10; *see also* S. J. H. Graham and D. Harhoff, *Would the U.S. Benefit from patent Post-grant Reviews? Evidence from a 'Twining' Study* (Mar. 2005: permission to cite?); S. J. H. Graham et al., *Post-Issue Patent "Quality Control": A Comparison of US Patent Re-examinations and European Patent Oppositions,* National Bureau of Economic Research, working paper no. w8807, 11 (Aug. 2002) (available at: http://emlab.berkeley/~bhhall/GHHM%20Nov02.pdf).

[31] *See, e.g.,* Patent Reform Act of 2007, S. 1455, 110th Cong. § 6 (2007). There are a number of research papers offering options to improve the current patent system, primarily to protect against opportunism using substandard patents. *See, e.g.,* J. Farrell and R. Merges, *Incentives to Challenge and Defend Patents: Why Litigation Won't Reliably Fix Patent Office Errors and Why Administrative Patent Review Might Help*, 19 BERKELEY TECHNOLOGY LAW REVIEW 1-28 (2004); D. Barker, *Troll or No Troll? Policing Patent Usage with an Open Post-Grant Review*, 2005 DUKE L. & TECH. REV. 0009 (2005) (available at: http://www.law.duke.edu/journals/dltr/articles/pdf/2005dltr0009.pdf) at 1 (proposing that all patents be reviewed openly "whenever patents are renewed or sold"); S. Graham and D. Harhoff, *Would the U.S. Benefit from Patent Post-grant Reviews? Evidence from a 'Twining' Study*, Unpublished Manuscript (June 2005); S. Graham and D. Harhoff, *Can Post-Grant Reviews Improve Patent System Design? A Twin Study of US and European Patents*, CEPR DISCUSSION PAPER NO. 5680 (2006); M. Meurer, *Controlling Opportunistic and Anti-Competitive Intellectual Property Litigation*, 44 BOSTON COLLEGE LAW REVIEW 509-544 (2003); J. Bessen and M. Meurer, *Lessons for Patent Policy from Empirical Research on Patent Litigation*, 9 LEWIS AND CLARK LAW REVIEW 1-27 (2005).

[32] *Walker Process Equip., Inc. v. Food Mach. & Chem. Corp.,* 382 U.S. 172, 179 (1965).

[33] *Software Patent Law, supra* n. 28 at 10.

permanent injunctions in patent disputes,[34] injunctive relief is still available to patent holders in the United States.[35] Jury trials to enforce patent rights and establish damages are not guaranteed in Europe as they are in the United States. In the United States, patent litigators often get a second bite of the apple as well, because the United States Court of Appeals for the Federal Circuit reviews all patent claim determinations under a *de novo* standard.[36]

Patent suits in the United States are also generally more expensive than in Europe. Estimates indicate that the costs of a patent lawsuit through discovery are about $1.5 million for each side.[37] These costs are substantially higher than that in several European countries. In Germany, for example, the cost of a suit range from approximately $20,000 to $53,000.[38]

We outline these differences between the European and United States patent regimes not to imply that the European regime is somehow preferable to the United States system, but simply to demonstrate how the United States system maintains a relatively "looser" system than Europe. That distinction is important as is serves as the basis for our estimation of deadweight losses and other costs described in Section IV below. As described below, a "loose" patent system discourages the development and filing of valid patents and creates a deadweight loss for the economy. We base this estimate on fact that even with a

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34 In the *eBay* decision, the Court reversed the Court of Appeals "general rule" unique to patent disputes "that a permanent injunction will issue once infringement and validity have been adjudged." *eBay, supra* n. 18, slip op. at 5. According to Chief Justice Roberts, "[f]rom at least the early 19th century, courts have granted injunctive relief upon a finding of infringement in the vast majority of patent cases." *Id.* (Roberts, C.J., concurring).

35 *TiVo Inc. v. Echostar Communications Corp.*, Final Judgment and Permanent Injunction, Docket 2:04-CV-1-DF (E.D. Tex. Aug. 17, 2006) (granting injunction against Echostar after *eBay* decision), *stay granted pending appeal,* Order, Docket No. 2006-1574, (Fed. Cir. Aug 18, 2006).

36 *Cybor Corporation v. FAS Technologies, Inc.*, 138 F.3d 1448, 1456 (Fed. Cir. 1998) (*en banc).* District Court Judge James F. Holderman has recently stated that because of this de novo standard of review in patent cases, "we United States District Court Judges feel like the late comedian Rodney Dangerfield, because our opinions 'get no respect.'" Judge J. F. Holderman, *The Patent Litigation Predicament in the United States,* University of Illinois Journal of Law, Technology & Policy Works in Progress(2007) (available at: http://www.jltp.uiuc.edu/works/Holderman.htm#_ftn1).

37 *See, e.g.,* J. Allison, M. Lemley, K. Moore, and R. D. Trunkey, *Valuable Patents*, UNIVERSITY OF CALIFORNIA AT BERKELEY, SCHOOL OF LAW, RESEARCH PAPER NO. 133 (2003).

38 R. Black, *Never Mind the Quality, Feel the Pinch,* MANAGING INTELL. PROP. (May 1, 2005) at 26.

tighter legal standard for patentability, Europe produces a higher share of "valid" patents than the United States. Therefore, while the European system has been criticized as being too "tight," its relatively more stringent granting practices allow it to serve as a basis for our estimation approach.

**III. The Equilibrium Level of Valid and Substandard Patents**

The basis of our argument is that substandard patents arising from a "loose" patent system reduce the number of valid patents by discouraging innovation. While this idea is generally accepted, we formalize it here by describing the "correct" level of patenting in the sense of the equilibrium values of valid and substandard patents. To begin, we divide total patents into two types: (1) valid patents ("$v$") and (2) substandard patents ("$b$"). Total patents are just $v + b$. Valid patents represent patents that are true inventions or discoveries in which the cost to society of granting a twenty-year monopoly to the patent holder are outweighed by the aggregate social benefit of the invention or discovery itself. Substandard patents are those which are granted that are of low quality (that is, for ideas that are not in fact new or non-obvious) or which create risks for valid patents through litigation and licensing. From the standpoint of our model, it is not necessary to assume that each and every patent of this sort is literally bogus, is created for a nefarious purpose, or is of no private value to the patentee. Our analysis simply assumes that such patents fall below an operative or ideal standard for approval and that they impose, on average, a harm to the economy as a whole but, specifically, a harm to so-called valid patents. More directly, the addition of a substandard patent reduces the private marginal benefit of a valid patent, and discourages the production of both valid and substandard patents (or inventions in general, whether patented or not).

To describe the equilibrium, we assume that patents (or patentable inventions) are ordered from highest to lowest, with resources devoted first to those patents with the greatest value. With diminishing marginal benefits to patents, the equilibrium number of valid patents, $v^*$, will solve:

$$A(x) - a \cdot v - c \cdot b = 0 \qquad (1)$$

where the expression is the net private marginal benefit of an additional valid patent.[39] The total benefit of valid patents is maximized where the marginal

[39] In both Equations (1) and Equation (2), infra, we have linear marginal benefits, but this assumption is not required and is for convenience only.

benefit of a valid patent is zero. The net marginal benefit includes a value $A(x)$, which is a function of exogenous factors $x$ such as the legal system for granting or challenging patents and the cost of enforcing patents. The parameter $a$ measures the reduction in the net marginal benefit of valid patents given the addition of one more valid patent, and the negative sign indicates diminishing marginal benefits.[40] The relationship between the number and creation of substandard patents and the marginal value of a valid patent is measured by the parameter $c$. Substandard patents, on the other hand, reduce the net marginal benefit of valid patents. This consequence arises primarily from opportunistic litigation or licensing. Although they both represent a reduction in the value of a valid patent, both $a$ and $c$ are expressed positive values.

The equilibrium number of substandard patents, $b^*$, will solve:

$$B(y) - d \cdot b + e \cdot v = 0 \tag{2}$$

where $B(y)$ is a scale factor for the net private marginal benefit of substandard patents, and its value is driven by a set of factors $y$. The factors $y$ will generally not be the same as $x$, but some overlap is to be expected. Intuitively, $y$ will encompass factors that measure the strength of the jurisdictional patent review process, the efficiency of the legal system, the generosity of patent infringement awards, legal costs, and so on. The parameter $d$ is the effect on net private marginal benefits from the addition of one more substandard patent, and $d$ is positive; the negative sign implies diminishing net marginal benefits. In contrast to Equation (1), an increase in the number of valid patents increases the net private marginal benefit of a substandard patent (because this increase creates more opportunities for litigation). The equilibrium number of both types of patents is determined by the condition that the marginal benefits of each are simultaneously equal to zero in the relevant jurisdiction.

Figure 1 is a graphical representation of the equilibrium. The figure has the number of substandard patents ($b$) on the vertical and valid patents ($v$) on the horizontal axis. The curves in the figures represent the loci of points where the marginal benefits of valid and substandard patents equal zero across the range of

[40] This reduction in marginal benefit presumably occurs because patent opportunities are exploited in order of decreasing expected net value, although the formulation is not inconsistent with the existence of an additional effect that reflects an actual reduction in the economic value due to competition between products which is increased or facilitated by new inventions.

values of both $b$ and $v$ (i.e., iso-marginal benefit curves). The intersection of the two defines the equilibrium. In the figure, the equilibrium has $b^*$ and $v^*$ patents.

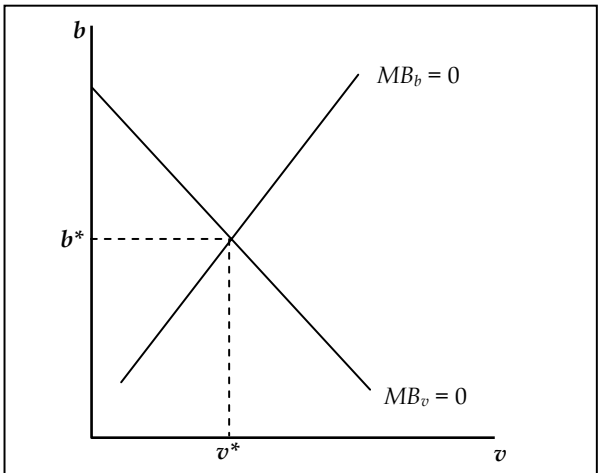


Figure 1. Patent Equilibrium

To demonstrate the comparative statics of the model, consider a court decision that makes the granting of substandard patents more difficult, such as the recent Supreme Court decision in *KSR* that overturned lower court's permissive interpretation of the "non-obvious" test for patentability. In the model, this legal change is represented by a change in $y$ that reduces $B(y)$. Consequently, the number of substandard patents should diminish. In Figure 2, we illustrate this as a change in $y$ to $y'$, causing a shift in the upward sloping iso-marginal benefit curve for substandard patents down and to the right. The new equilibrium is $b^{**}$ and $v^{**}$, where substandard patents fall and valid patents rise. Given our observation above that substandard patents diminish the value of valid patents and, therefore, reduce the incentive for firms to obtain such valid patents, upon the legal change that decreases the number of substandard patents, the number of valid patents will be expected to rise.

The comparative statics of the other parameters are similarly intuitive. Put simply, anything that increases the value of valid patents increases both $b$ and $v$. Any change that increases the value of substandard patents, reduces $v$ and increases $b$. For example, a change in $x$ that makes valid patents more difficult to enforce will shift the iso-marginal benefit curve ($MB_v = 0$) down and to the left, thereby reducing both equilibrium valid and substandard patents.

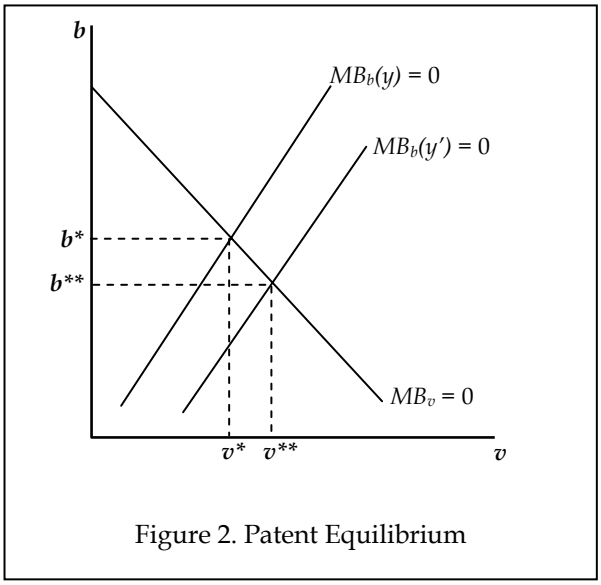


Figure 2. Patent Equilibrium

The most important point about this analysis is that it illustrates an aspect of the problem of the United States patent system that has received insufficient attention. In particular, since the numbers of both types of patents affect the marginal values of each, any policy change that affects either relationship will, in equilibrium, affect the numbers of both types. Of special potential concern is the size of the effect of substandard patents on the values of valid patents. To the degree that valid patents, as described here, have much larger net social values, a patent system that allows too many substandard patents is likely to reduce the extent of innovation valid patents support, reducing economic welfare. This dampening effect may be far more important than the direct costs of litigation and licensing, much of which will necessarily involve transfers. While direct legal costs are surely not *de minimis*, the discouragement of innovation, in the long run, will almost certainly swamp these more easily counted "direct" costs.

We also note that the underpinnings to our approach are conceptual. For example, we note that there is no need to assume that the socially optimal number of substandard patents need be zero, especially because there are costs associated with reducing substandard patents. For instance, adopting a patent regime that sets the bar high for granting any patent would certainly reduce or even eliminate the level of substandard patents, but that decision also could reduce the number of valid patents as well and therefore impose welfare losses on the economy. The administrative costs (and risk of mistakes) of sorting through valid and substandard patents may also be extraordinarily high. Like most things in economics and public policy, such a complete foreclosure of

substandard patents would probably be too costly to be optimal in the real world. As a result, the efficient balance should be sought, and that appropriate balance is what a good patent policy must continually strive to achieve.

In addition, we are not assuming, and do not suggest, that substandard patents are intentionally created to use in opportunistic, socially destructive litigation or royalty seeking. It seems probable that very few patents are created with that primary end in mind. Rather, when the patent system is sufficiently "loose" in granting patents, and patents are had cheaply enough, firms and others will patent devices and procedures that are of limited commercial potential. In such cases, the possibility of obtaining an infringement award, or of licensing to others seeking legal defense, becomes a non-negligible consideration that encourages the patentee to proceed. Such expectations, of course, need to be accurate in equilibrium, so it must be the case that some opportunistic exploitation occurs. Since a patent is often an alternative to other means of protecting intellectual property, such as trade secret activity, one would expect that an increase in the number of potentially threatening patents would reduce the marginal benefit of a "valid" patent effort.

## IV. Quantifying the Costs of Substandard Patents

As discussed above, the presence of substandard patents leads to a reduction in the number of valid patents. In this section, we attempt to quantify the loss of valid patents in the United States due to substandard patents, and then put a monetary value on that loss. As a first step, we estimate the number of valid patents lost to substandard patents. To do so, we assume, as have others, that triadic patents—i.e., those in which the inventor seeks patent protection in the United States, Europe and Japan—are "relatively important" patents and are, to a large extent, generally regarded as "valid" patents.[41] The validity of such patents is, to a large extent, based on the fact that the patent must be granted by three patent offices (the USPTO, the EPO, and the JPO). By most accounts, the EPO is the most stringent in its requirements and evaluations, and we use that presumption below to specify some parameters of our estimation approach. We do not intend, however, to imply that the European patent system is the "correct" system. Rather, we assume, given the differences in the legal regime, that patents issued by the EPO are less likely to be substandard patents. This

[41] Jaffe and Lerner, *supra* n. 1 at 142-43.

assumption, however, does not imply that the EPO system is in some sense ideal or perfect.

Substandard patents are harmful in (at least) three respects.[42] In particular, substandard patents may reduce future innovation by discouraging research and development in a particular area for fear of infringing, or directing research away from valid to substandard opportunities.[43] This reluctance to enter could affect market structure and prices. Second, substandard patents may induce unnecessary licensing royalties, distorting the incentives the patent system was designed to provide. Third, legal challenges to substandard patents can result in socially wasteful litigation costs. Our focus here is on the first harm, and we attempt to estimate the welfare losses from high numbers of substandard patents. We believe these costs will be the largest of the three, and our rough estimates of the other costs indicate that this is true.

A. *Lost Patents*

The presence of substandard patents clearly reduces the incentives for firms to innovate.[44] Yet, there is no direct evidence of which we are aware on the

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[42] *See, e.g.,* R. Levin, A. Klevorick, R. Nelson, S. Winter, R. Gilbert, and Z. Griliches., *Appropriating the Returns from Industrial R&D*, 1987 BROOKINGS PAPERS ON ECONOMIC ACTIVITY 783-831 (1987) and United States Federal Trade Commission, TO PROMOTE INNOVATION: THE PROPER BALANCE OF COMPETITION AND PATENT LAW AND POLICY (Oct. 23) at ch. 5.

[43] *See, e.g.,* R. Merges and R. Nelson, *On the Complex Economics of Patent Scope*, 90 COLUMBIA L. REV. 839 (199); S. Scotchmer, *Standing on the Shoulders of Giants: Cumulative Research and the Patent Law*, 5 J. OF ECON. PERSPECTIVES 29 (1991); N. Gallini and S. Scotchmer, *Intellectual Property: When is it the Best Incentive System?*, in A. Jaffe, J. Lerner and S. Stern, eds., INNOVATION POLICY AND THE ECONOMY, Vol. 2 (2001).

[44] J. Lanjouw and J. Lerner, *Tilting the Table? The Use of Preliminary Injunctions*, 44 J. OF LAW AND ECON. 573 (2001); J. Lerner, *Patenting in the Shadow of Competitors*, 38 J. OF LAW AND ECON. 463 (1995). Hunt claims that the weakening of the nonobviousness requirement by domestic courts lead to more but weaker patents, and discouraged R&D activity. R. Hunt, *Nonobviousness and the Incentive to Innovate: An Economic Analysis of Intellectual Property Reform*, Federal Reserve Bank of Philadelphia Working Paper No. 99-3 (1999); *see also,* Judge T.S. Ellis, *Distortion of Patent Economics by Litigation Costs*, Address at the 1999 CASRIP Summit Conference, in 5 CASRIP PUBLICATION SERIES: STREAMLINING INT'L INTELLECTUAL PROPERTY 22 (1999) (available at http://www.law.washington.edu/casrip/Symposium/Number5/pub5atcl3.pdf) ("My thesis today is neither revolutionary nor abstruse. On the contrary, it is no more than a modest, straightforward, common-sensical observation that has likely already occurred to many veteran viewers of the patent scene. It is, simply put, that the escalating, indeed skyrocketing litigation costs of the 1970's and 1980's have distorted patent markets and patent economics. Put another

(Footnote Continued. . . .)

precise extent of research deterrence. In an effort to approximate the number of lost "valid" or "relatively important" patents lost due to the presence of substandard patents, we assume the production of relatively important patents is a linear function of R&D expenditures.[45] Thus, the number of triadic patents filed by country *i* in period *t* is described by

$$F_{i,t} = \beta \cdot RND_{i,t} + \theta \cdot DUS + \sum_{j=1}^{T} \alpha_j D_j + \varepsilon_{i,t} \quad (3)$$

where $F_i$ is the number of triadic family patents for country *i* in period *t*, *RND* is the real research and development expenditures for country *i* in period *t*, *DUS* is a dummy variable for the United States, the $D_j$ are $T$ (= $\Sigma t$) period specific dummy variables, and $\varepsilon_{i,t}$ is the econometric disturbance term.[46] The coefficient $\theta$ measures the extent to which the United States either under- or over-produces valid patents relative to other countries.

All of the data required to estimate Equation (3) is from the OECD's MAIN SCIENCE AND TECHNOLOGY INDICATORS. The variables are expressed in annual terms and cover the period 1995 through 2003. The variable *RND* is measured in two ways: civil R&D and total R&D (both civil and defense), and both are measured in real dollars (in millions).[47] There is some evidence suggesting that defense spending on R&D generates few patents, and the United States spends

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way, it is my observation that the escalating costs associated with litigating patent infringement and validity issues discourage challenges to patents, thereby essentially equating the entry barriers for presumptively valid, but weaker patents with those entry barriers associated with strong or judicially tested patents").

[45] We also evaluating log transformations of the variables using comparable $R^2$ values, but the linear specification is superior to these alternatives.

[46] All of the data required to estimate Equation (3) is from the OECD's MAIN SCIENCE AND TECHNOLOGY INDICATORS (Subscription Service). The variables are expressed in annual terms and cover the period 1995 through 2003, and with missing variables the sample size is 299 observations. The model is estimated using least squares with period dummy variables to account for the time series nature of the data. The coefficients are highly statistically significant and are $\beta_0$ = -396.6, $\beta_1$ = 0.10, and the year 2003 constant is -105.2. Overall, the model performs well, with an $R^2$ of 0.80. The linear specification fits the data quite well, much better than either the log-lin or log-log specifications.

[47] The GDP deflator is provided in the OECD data for those countries included in the sample.

far more on defense R&D than any other country in the sample.[48] Thus, using only "Civil R&D" (i.e., total R&D less defense-related R&D) provides a more conservative estimate of the number of lost valid patents. To demonstrate the conservative nature of using only Civil R&D expenditures, we also present the results with the variable R&D measured using total R&D expenditures for comparison purposes. Given the large number of missing observations on the share of Civil R&D spending, the share variable is assumed to be constant over the sample period (based on the average of available data).[49] We do not suspect this will bias the results significantly, since the available data suggests the civil share across all countries is very stable over time.

The OECD data provides data on 38 countries; there are some missing observations. We present the results of the estimation using three sets of countries. Sample A includes 30 countries with 227 total observations.[50] This sample includes all countries for which the necessary data is available. For Sample B, we include only countries in the European Union and the United States, since the patent and legal regimes in these countries are more likely consistent with that of the United States.[51] Finally, in Sample C, we include all 38 countries available.[52] In this sample, however, we are limited to total R&D expenditures in nominal terms due to a lack of data. The results from this sample are provided for illustrative purposes only, and we do not discuss them in detail.

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48 A. Chakrabarti and C. Anyanwu, *Defense R&D, Technology, and Economic Performance: A Longitudinal Analysis of the US Experience*, 40 IEEE TRANSACTIONS ON ENGINEERING MANAGEMENT 136-145 (1993).

49 For all years the data is available, we compute the ratio of Civil to Total R&D (as a percentage of GDP), and then average these for each country.

50 We have 30 countries and 9 years of data for a total of 270 potential observations, but there are missing values. The countries in Sample A include Australia, Austria, Belgium, the Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, New Zealand, Norway, Portugal, Slovak Republic, Spain, Sweden, Switzerland, United Kingdom, United States, Argentina, Romania, the Russian Federation, Slovenia, South Africa, and Chinese Taipei.

51 The countries in Sample B include Belgium, the Czech Republic, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Portugal, Slovak Republic, Spain, Sweden, Switzerland, United Kingdom, United States, and Slovenia.

52 Thus, Sample C includes all countries listed in n. 50, *supra,* and Canada, Hungary, Mexico, the Netherlands, Poland, Turkey, China, Israel, and Singapore.

The model is estimated using least squares with period dummy variables to account for the time series nature of the data.[53] Table 1 summarizes the results. Alternative procedures for computing the standard errors render no significant changes, so the t-statistics are based on the ordinary standard errors. All the variables are statistically significant. The model fits the data very well, with $R^2$ values of about 0.97 across all specifications (except for Sample C, with an $R^2$ of 0.92). The good fit is not surprising given the time series component of the data.

Turning to the number of lost patents (measured by $\theta$ in Equation 3), across Samples A and B we observe similar estimates when using Civil R&D expenditures. The more conservative number, and probably the more sensible one given the comparison is across the United States and EU countries only, is 7,266 triadic patents, with 90% confidence interval boundaries of 6,205 and 8,327 [$se(\theta) = 642.7$]. In the larger Sample A, lost patents rises to 8,447, with a 90% confidence interval bound by 7,715 to 9,181.

For both samples, the estimate of lost triadic patents is larger when using total R&D expenditures (12,004 and 9,406, respectively). This difference and its direction were expected, given the higher percentage of defense related expenditures in the U.S. and the low patent productivity of such expenditures. To be conservative, we assume there are 7,000 lost triadic patents due to the presence of substandard patents in the United States, a round number that is at the lower end of our approximation technique (i.e., $\theta = 7,266$).

[53] Using a time trend rather than dummy variables has almost no effect on the results.

**Table 1. Estimation of Lost Patents, Regression Results**

| Variable | Sample A | | Sample B | | Sample C |
|---|---|---|---|---|---|
| | Coefficient (t-stat) | Coefficient (t-stat) | Coefficient (t-stat) | Coefficient (t-stat) | Coefficient (t-stat) |
| Constant | -404.35 | -417.79 | -249.60 | -211.30 | -332.20 |
| | (-8.23) | (-7.14) | (-4.63) | (-3.51) | (-4.89) |
| *RND* (Civil R&D) | 0.123 (60.19) | … | 0.115 (36.44) | … | … |
| *RND* (Total R&D) | … | 0.117 (50.19) | … | 0.105 (32.00) | … |
| *RND* (Total R&D, Nominal) | … | … | … | … | 0.103 (35.50) |
| *DUS* | -8447.96 | -12003.74 | -7266.10 | -9405.96 | -8445.48 |
| | (-19.01) | (-20.18) | (-11.30) | (-11.82) | (-11.29) |
| *Period Constants* | | | | | |
| 1995 | -73.18 | -65.06 | 18.02 | 30.49 | 154.68 |
| 1996 | -24.38 | -13.81 | 50.41 | 63.51 | 151.71 |
| 1997 | 50.93 | 53.62 | 63.11 | 67.97 | 135.30 |
| 1998 | 4.39 | 5.69 | -5.49 | -1.89 | 67.73 |
| 1999 | 101.16 | 102.23 | 24.40 | 19.89 | 82.75 |
| 2000 | 51.45 | 45.43 | -1.93 | -10.63 | -10.12 |
| 2001 | -9.92 | -16.89 | -55.26 | -64.45 | -109.85 |
| 2002 | -67.83 | -71.36 | -50.51 | -52.54 | -213.70 |
| 2003 | -37.68 | -43.37 | -43.92 | -52.56 | -234.70 |
| $R^2$ | 0.98 | 0.97 | 0.98 | 0.98 | 0.92 |
| Cross Sections | 30 | 30 | 19 | 19 | 38 |
| Observations | 227 | 227 | 148 | 148 | 299 |

Of course, a patent can be valid without being triadic (but we are assuming triadic patents are valid), since not all valid patents are worth filing triadically. As an approximation to the number of valid to triadic patents, we assume that more rigorous standards of the EPO render only valid patents. (We relax this assumption later in our estimation procedure.) The (average) ratio of valid patents to triadic patents can be approximated by

$$P_{i,t} = \lambda \cdot F_{i,t} + \sum_{j=1}^{T} \alpha_j D_j + \varepsilon_{i,t} \quad (4)$$

where $P_{i,t}$ is the number of patent applications by country $i$ in period $t$. Equation (4) is estimated in the same way as Equation (3) with period dummies $D_j$.

Sample B is used since it includes only EU countries (18 countries, 162 observations). The λ coefficient is estimated to be 3.0 (*t-stat* = 120.3).[54] So, the ratio of total valid patents to triadic patents in a jurisdiction is approximately 3.0. Given λ = 3 and a loss of 7,000 triadic patents due to the presence of substandard patents, both estimated above, the total loss of valid patents in the US per year is estimated to be 21,000 patents (about 10% of patents granted annually by the USPTO).

Assuming a 20% leakage in the EPO of substandard patents, reducing λ to 2.4, we have 16,800 lost valid patents in the U.S. annually due to the research deterrence effects of substandard patents. If the EPO is too stringent, say leading to the rejection of 20% of valid patents filed, then λ is 3.6 and lost US valid patents is approximated by 25,200. We can also vary the assumed loss of triadic patents, perhaps according to the estimated confidence interval, for even more approximations of the total loss of valid patents in the US. Given the imprecise nature of all of these calculations, we believe it is prudent to consider a range of options when estimating the welfare loss from substandard patents.

Having set forth a method for determining the number of lost patents, the next step requires an estimate of how much each patent is worth. There exists a substantial literature on the economic value of patents.[55] For our purposes, the most useful estimate is by Cockburn and Griliches (1988), who estimate the average economic value of a patent as (US) $1 million (in current dollars) or $2.4 million adjusting for both inflation and economic growth.[56] Certainly, the distribution of value is highly skewed, but for our calculations the average is suitable. To be conservative, for the benchmark case we assume an average value per valid patent of $1 million, and we will also consider a range of potential values.

The calculation of the deadweight welfare loss from substandard patents is

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[54] The $R^2$ of the model is 0.99.

[55] I. Cockburn and Z. Griliches, *Industry Effects and Appropriability Measures in the Stock Market's Valuation of R&D and Patents*, 78 AMERICAN ECONOMIC REVIEW: PAPER AND PROCEEDINGS 419 (1988) (providing a per-patent estimate of value).

[56] *Id*. We use the consumer price index to convert the year 1980 estimate of $500,000 to current dollars (258 in 1980 to 604 in 2006), and for economic growth we include the growth in GDP over the same period (data from www.bea.gov).

$$DWL = \lambda \cdot P_{LOST} \cdot V_{VALID} \quad (5)$$

where $P_{LOST}$ is lost valid patents and $V_{VALID}$ is the average value of a valid patent. In our benchmark case, we have

$$DWL = 3 \cdot 7{,}000 \cdot 1{,}000{,}000 = 21{,}000{,}000{,}000\,, \quad (6)$$

so our "point" estimate of the deadweight loss from substandard patents is $21B annually. Given annual R&D expenditures in this US of about $300 billion, these losses represent about 7% of total R&D spending per year.

We do not wish to exaggerate the precision of our estimation approach. A rudimentary sensitivity analysis seems unnecessary given the simple form of the damage calculations (in Equation 5). For example, if we assume any of the inputs to the calculation is understated by 10%, then the estimated cost increases by 10%.

We do think a simulation approach that estimates a distribution of plausible values may be useful. In this simulation, we take our "point" estimates of the three inputs to Equation (5) as mean values, and allow each to vary according to a specified distribution. From the econometric estimate of $P_{LOST}$, we observed a coefficient of variation of about 0.10 (i.e., standard error of the coefficient divided by the mean). For our simulation, then, we assume that $P_{LOST}$ is distributed normally with mean 7,000 and standard deviation 700. We also assume that $V_{VALID}$ is distributed normally also with a coefficient of variation of 0.10 (so the 95% confidence interval is 0.8M to 1.2M). For $\lambda$, we also assign a coefficient of variation of 0.1, and this choice renders a 95% confidence interval bound by 2.4 and 3.6. Our simulation includes 10,000 draws of random numbers from these distributions, and these numbers are inserted into Equation (5) to compute the cost of substandard patents. The resulting distribution is illustrated in Figure 3.

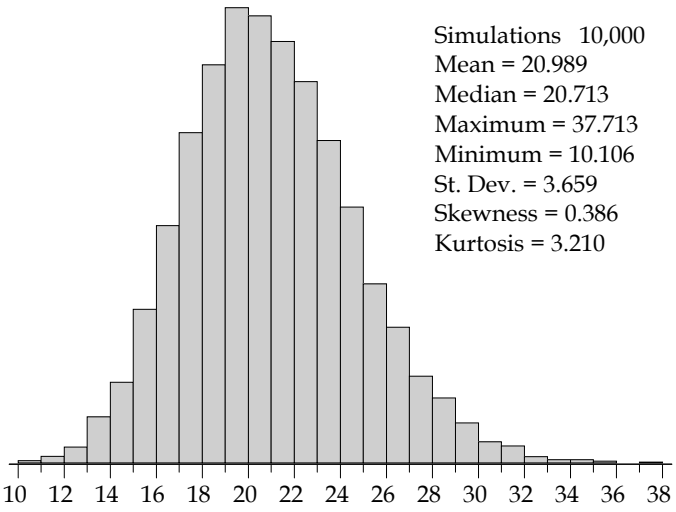


Figure 3. Simulated Distribution of Deadweight Loss

Figure 3 is the histogram of welfare costs of substandard patents from the simulation. The simulated mean of costs ($20.989 billion) is essentially equal to the $21 billion from Equation (6), as expected. The standard deviation is about $3.6 billion (about 17% of the mean). The distribution has a slight positive skew, so it is not symmetrical. Repeating the simulation 100 times indicates the upper and lower bounds of the 95% confidence interval are $14.4 billion and $28.7 billion.[57] For this particular simulation, the minimum value is about $10 billion and the maximum about $38 billion.[58] We stress, however, that these calculations are illustrative since the nature of the random process is somewhat arbitrary specified. But, even with wide variation in the assumptions, the estimate of cost remains very high even at its smallest value ($10 billion annually).

[57] This confidence interval is not symmetric around the mean (-6.6B and +7.7B).

[58] Given the very large number of simulations, the minimum, maximum, and confidence intervals are stable across runs.

B. *Other Deadweight Losses*

As mentioned above, we suspected that the research deterrence costs would be the largest of the deadweight losses from a loose patent system. There are, however, other costs. One direct cost of substandard patents relates to the typical administrative costs of pursuing substandard patents including legal fees, application fees, and the cost of the USPTO. These costs are deadweight losses. In the United States, the legal and filing fees are estimated to be a few thousand dollars for even a simple patent to upwards of $25,000 for more complex technologies. Offered estimates of costs from a variety of sources typically fall in the $3,000 to $25,000 range per application. [59] For our computations, we assume that the patent application costs $7,500, on average, in legal and administrative fees.[60]

These costs must be applied to some estimate of the number of substandard patents filed each year. According to OECD data, over the five-year period 1999 through 2003, there were 90,445 triadic patents filed from the United States.[61] From above, we estimated the ratio of valid patents to triadic patents to be 3.0.[62] Applying our $\lambda$ to the United States, we would expect that there would be approximately 271,335 valid patent applications in the United States over this period. However, there were 594,827 filings by entities at the USPTO in this

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[59] E. Quinn Jr., *Cost of Obtaining a Patent*, ipwatchdog.com. On average, the USPTO's average cost per patent reviewed is about $4,000. *See also,* http://www.techtransfer.umich.edu/inventors/patents.html; http://www.basicpatents.com/patcost.htm; http://www.inventored.org/novice/; http://www.dnapatent.com/law/cost.html; http://www.costhelper.com/cost/small-business/patent.html. In some cases, patent prosecution costs must be incurred which could increase the cost by another $5,000 to $15,000. United States Dept. of Commerce, F2006 PERFORMANCE AND ACCOUNTABILITY REPORT (2006), (available at: http://www.osec.doc.gov/bmi/Budget/06APPR/PAR06.pdf ), App. A at 316.

[60] Over the period 2003 through 2005, the USPTO earned about $3.3 billion in revenue for 1.14 million applications, for an average application cost of about $3,000. United States Patent and Trademark Office, PERFORMANCE AND ACCOUNTABILITY REPORT FISCAL YEAR 2006, MANAGEMENT'S DISCUSSION AND ANALYSIS (2006).

[61] OECD, MAIN SCIENCE AND TECHNOLOGY INDICATORS (database: multiple years).

[62] For that same period, European countries (EU25) filed 79,295 triadic patents and 250,275 applications at the EPO. Thus, dividing the two, we compute a $\lambda$ of 3.16, which is very close to our estimated $\lambda$ of 3.0.

period, which suggests that approximately half of all U.S. patents filed are substandard.

While this percentage of substandard patents is high, it is consistent with other evidence. For example, Graham and Harhoff (2005) calculate that about 40% of U.S.-granted patents are rejected by the EPO, though the number is found to be much lower (about 4%) in Jensen et al. (2005).[63] Not all United States patents are also filed at the EPO (about 60% of United States patents are filed before the EPO), but one would initially think that those filed at the EPO by American entities would be of relatively high quality. Allison and Lemley (1998), in a study of patents litigated over the period 1989 through 1996, reveal that about half of litigated patents are invalidated at trial.[64] Further, Trajtenberg (1990) argues that cited patents, and not simple patent counts, are correlated with patent value. In his data, about half of patents are not cited, again suggesting that about half of patents may be classified as substandard.[65] Finally, Jaffe and Lerner (2004) summarize evidence from the OECD indicating that patents in that the growth rate of USPTO granted patents is twice that of "economically significant" (or triadic) patents.

Assuming 50% of filings are substandard and there are 400,000 filings per year, there are about 200,000 substandard patent filing at the USPTO annually. At an average cost of $7,500 per application, the annual deadweight loss from administrative costs related to the acquisition of substandard patents is $1.5 billion. While this is certainly a large number and a significant cost of

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[63] S. J. H. Graham and D. Harhoff, *Would the U.S. Benefit from Patent Post-grant Reviews? Evidence from a 'Twining' Study*, Working Paper (Mar. 2005); P. Jensen, A. Palangkaraya and E. Webster, *Patent Application Outcomes across the Trilateral Patent Offices*, INTELLECTUAL PROPERTY RESEARCH INSTITUTE OF AUSTRALIA WORKING PAPER NO. 06/05 (2005). Grant rates are highly contested figures. *See, e.g.*, C. Quillen Jr and O. Webster, *Continuing Patent Applications and Performance of the U.S. Patent Office*, 11 FEDERAL CIRCUIT BAR J. 1 (2001) ("The Grant Rate (allowances divided by total disposals, *i.e.*, the sum of allowances and abandonments) for the USPTO for its fiscal years 1993-1998, corrected for continuing applications, ranges from 87% to 97%, depending on the extent to which prosecution of abandoned applications was continued in re-filed applications. Reported Grant Rates for 1995-1999 for the European and Japanese Patent Offices (averaged) are 67% and 64%, respectively.").

[64] J. Allison and M. Lemley, *Empirical Evidence on the Validity of Litigated Patents, Working Paper*, 26 AMERICAN INTELLECTUAL PROPERTY LAW ASSOCIATION QUARTERLY J. 185 (1998).

[65] M. Trajtenberg, *A Penny for Your Quotes: Patent Citations and the Value of Innovations*, 21 RAND J. OF ECONOMICS 172 (1990).

substandard patents, it is far below the costs of research deterrence caused by substandard patents.

Substandard patents also lead to litigation. While judgments are properly viewed as transfers, the costs of obtaining judgments (or royalties) are deadweight losses. In order to determine the expected cost of litigation from substandard patents, we need an estimate of the probability a patent is litigated and the cost of litigation. As for litigation rates, Lanjouw and Shankerman (2001) find a domestic litigation rate of about 1.6% during the early 1980's, and Lanjouw and Shankerman (2003) find a 1.9% litigation rate.[66] Allison et al. (2003) report a 3.2% litigation rate.[67] The litigation rate from these studies depend on a number of things including the stock of patents and time period evaluated.

For our purposes, we are constructing annual estimates of the cost of substandard patents. Federal statistics indicate that there are approximately 3,000 patent cases filed annually. Allison et al. (2003) show that most litigated patents are younger, typically being three years or less.[68] Thus, we construct a patent stock of relatively recent patents. Over the past five years, the USPTO has granted nearly one million patents, so we assume the stock of patents is 1 million and construct an annual litigation rate using that stock.[69] So, a reasonable proxy for the annual litigation rate is 0.3% (or 3 cases per 1,000 patents) on the stock of patents.

The cost of litigation varies substantially across patents, but the average is typically claimed to be in the $1 million to $4 million range for the discovery

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[66] J. Lanjouw and M. Schankerman, *Characteristics of Patent Litigation: A Window on Competition*, 32 RAND JOURNAL OF ECONOMICS 129 (2001); J. Lanjouw and M. Schankerman, *Stylized Facts of Patent Litigation,* Presentation before Nat'l Acads., Board on Science, Technology and Economic Policy Conference on *Intellectual Property Rights: How Far Should They Be Extended?* (2000) (available at: http://www7.nationalacademies.org/step/Lanjouw_ppt.ppt); K. A. Moore, *Judges, Juries and Patent Cases – An Empirical Peek Inside the Black Box*, 99 MICHIGAN LAW REVIEW 365 (2000) (damage awards exceed $1 million in about 50% of cases).

[67] J. Allison, M. Lemley, K. Moore, and R. D. Trunkey, *Valuable Patents*, University of California at Berkeley, School of Law, Research Paper No. 133 (2003).

[68] *Id.*

[69] United States Patent and Trademark Office, U.S. PATENT ACTIVITY, CALENDAR YEARS 1790 TO THE PRESENT, TABLE OF ANNUAL U.S. PATENT ACTIVITY SINCE 1790 (2006).

phase (about half the cost of a full trial).[70] Allison et al. (2003), citing the American Intellectual Property Law Association, state that a patent case can cost $1.5 million per side.[71] Only about 5% of cases actually go to trial, with 95% being settled at some point in the process.[72] In a recent economic simulation of patent litigation, Graham and Harhoff (2005) use a cost of litigation of $4 million based on estimates from the American Intellectual Property Law Association.[73]

In light of the evidence, as a benchmark we assume a litigation rate of 0.3% and a litigation cost of $2 million per case. The stock of patents is assumed to be one million (which approximates patents granted in the past five years) and we assume that half the patent stock is substandard. Thus, the approximate deadweight loss from the litigation of substandard patents is $3 billion annually.[74] While this is a very large number, it remains much smaller than the $21 billion annual cost of research deterrence.

C. *Review of the Evidence*

Our analysis shows that the cost of a "loose" patent system that is prone to grant substandard patents is very high. Much of the cost is attributable to the reduced innovation, but the administrative and litigation costs are non-trivial. We estimate that annually, the deadweight loss from reduced innovation is $21 billion, administrative costs $1.5 billion, and litigation costs $3 billion. The total of these deadweight losses that we calculate is $25.5 billion annually. We stress that these estimates are preliminary. As such, we have provided a range of probable values to demonstrate the change in estimates given alternative assumptions. Certainly more research is needed on this very important topic.

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[70] Coalition for Patent Fairness, *The Case for Reform* (available at: http://www.patentfairness.org/CPF_White%20paper%20v3.pdf); American Intellectual Property Lawyers Association, 2005 REPORT OF ECONOMIC SURVEY (2005); American Intellectual Property Lawyers Association, 2003 REPORT OF ECONOMIC SURVEY (2003) at 4; B. Hall, *A Patent System for the 21st Century*, The National Academies (2004).

[71] Allison *et al.*, *supra* n. 67.

[72] F. Cesaroni and P. Guiri, *Intellectual Property Rights and Market Dynamics*, LEM WORKING PAPER SERIES 2005/10 (May 2005).

[73] Graham and Harhoff, *supra* n. 63.

[74] The calculation is 0.50·1000000·0.003·2000000 = $3B.

## V. Conclusion

The purpose of patent policy is to balance the incentive to invent with the ability of the economy to utilize and incorporate new inventions and innovations. Because patent law grants *de jure* monopolies to patent holders and provides those holders with substantial rights to prevent infringement or sue for substantial damages, it is crucial that such patents be awarded only for truly original innovations. As Justice Kennedy recently wrote,

> We build and create by bringing to the tangible and palpable reality around us new works based on instinct, simple logic, ordinary inferences, extraordinary ideas, and sometimes even genius. These advances, once part of our shared knowledge, define a new threshold from which innovation starts once more. And as progress beginning from higher levels of achievement is expected in the normal course, the results of ordinary innovation are not the subject of exclusive rights under the patent laws. Were it otherwise patents might stifle, rather than promote, the progress of useful arts.[75]

In this POLICY PAPER, we examine some of the deadweight losses that result from a substandard patent system in the United States. We find that the current patent system in the United States imposes a significant economic cost on the economy. Under plausible assumptions, these costs can be $21 billion per year from deterrence of valid research. Deadweight losses from litigation and administrative costs add $4.5 billion annually. These estimates may be viewed as conservative because they do not take into account other economic costs from our dented patent system, such as the consumer welfare losses from granting monopoly rents to patent holders that have not, in the end, invented a novel product, or the loss of social value (in excess of the private value) of lost innovation.

We encourage proper caution in interpreting our findings. The models we use are simplified in many respects. As a consequence, our cost estimates should be viewed as preliminary or approximations. Further, we make no effort to "prove" either theoretically or empirically that the United States patent system is defective since there appears to be consensus on that point. Given the recent attention placed upon patent reform, our purpose is to provide estimates of the

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[75] *KSR, supra* n. 20, 127 S.Ct. at 1746.

costs that the defective system imposes on society. In that, our preliminary estimates show that these costs are substantial, and the severity of the problem indicates that additional research and study of this important public policy topic is warranted.