

# Would the U.S. Benefit from Patent Post-grant Reviews? Evidence from a 'Twinning' Study

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June 2005

## Abstract

We assess the impact of a post-grant review system in the U.S. patent system by comparing the “opposition careers” of EPO equivalents of litigated U.S. patents to those of a control group of EPO patents. We find that equivalents of litigated patent applications are more likely to receive patent protection than control group patents, and that the opposition rate for equivalents of litigated patents is about three times higher than for control group patents. Patents attacked under opposition are either revoked completely or narrowed in about 70 percent of all opposition cases. In the case of EPO equivalents of U.S. litigated patents, the appeal rate against opposition outcomes is considerably higher than for control-group patents. Based on our estimates, we calculate a range of net welfare benefits that would accrue from adopting a post-grant review system. Our results provide strong evidence that the United States would benefit substantially from adopting an administrative post-grant patent review. (155 words)

## Acknowledgements

We would like to thank Markus Herzog, Jürgen Lachnit, Michael Schramm, Michael Wallinger, and other anonymous German patent attorneys for fruitful discussions on the comparative merits of opposition and litigation in Europe and the United States. We also wish to acknowledge helpful comments from seminar audiences in Berkeley and Copenhagen. All remaining errors are our own. Research for this paper was supported by the Center for International Business Education and Research (CIBER) at the Georgia Institute of Technology and by a research grant within the SFB/TR15 research project of the Deutsche Forschungsgemeinschaft (DFG).

## 1 Introduction and Research Questions

A number of prominent policy panels in the U.S. have recently recommended the adoption of a post-grant review mechanism in the U.S. patent system. The Federal Trade Commission (2003),<sup>1</sup> the U.S. Patent and Trademark Office (2003),<sup>2</sup> and the American Intellectual Property Law Association (2004)<sup>3</sup> have followed a major academic study on patent reform produced by the National Academies (2003) - and earlier work by Merges (1999) - in calling for some form of post-grant administrative review of patent quality. The well-established evidence on which each of these proposals build shows that: litigation is currently the only effective mechanism for challenging U.S. patent quality *ex post*; litigation is an extremely costly mechanism for testing patent quality in an economy driven by technological innovation; and patent litigation imposes a substantial welfare loss on society (Graham et al. 2003; Levin and Levin, 2003; Hall et al., 2004). A proposal mirroring in important respects that of the American Intellectual Property Law Association (AIPLA) is pending as a bill before the U.S. Congress as House Resolution 2795 titled "The Patent Reform Act of 2005," co-sponsored by Reps. Howard Berman (D.-Calif.) and Lamar Smith (R.-Texas). Among the perceived benefits flowing from a post-grant review are a reduction in the costs society suffers from patent litigation (Graham, et al., 2003; Merges and Farrell, 2004), an increase in society's benefits from a quickening of the pace of innovation, and a limitation on unwarranted grants of market power (Hall, et al., 2004). Other benefits may include an improvement in patent quality and the establishment of an early feedback mechanism to patent examiners as regards the quality of their work.

Despite the positive assessment that post-grant review has received from the academic and administrative bodies, there remain open questions as to the efficacy and possible shortcomings of such an institution, particularly as it may apply in the United States. While a post-grant review has been used in the patent systems of several European jurisdictions and Japan, the innovation system in the United States is sufficiently unique so as to increase uncertainty concerning the applicability of a post-grant system in the U.S. Therefore, in the context of this rapidly developing policy environment, several fundamental questions remain unanswered: What effects will the United States adopting a post-grant review process have upon rates of patent litigation? And what welfare gains can society anticipate from a more cost-effective and rapid resolution of uncertainty concerning patent validity? Our paper uses novel data and methods to address these questions.

We employ a kind of twin study design applied in Graham et al. (2003) to U.S. patent re-examination and European opposition. In this paper, we consider the "opposition career" of equivalents of U.S. litigated patents at the European Patent Office (EPO). Comparing outcomes in the two systems is attractive since the EPO is today the dominant patent-granting institution in Europe. Moreover, much of the U.S. policy debate has taken EPO opposition

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<sup>1</sup> Federal Trade Commission, *To Promote Innovation: The Proper Balance of Competition and Patent Law and Policy*. Federal Trade Commission: Washington (2003).

<sup>2</sup> U.S. Patent and Trademark Office (2003). *The 21st Century Strategic Plan*. USPTO: Washington, D.C., February 2003 update: 6-14.

<sup>3</sup> American Intellectual Property Law Association (2004). "AIPLA Response to the October 2003 Federal Trade Commission Report: 'To Promote Innovation: The Proper Balance of Competition and Patent Law and Policy.'" AIPLA: Washington, D.C., 1-4.

and appeal proceedings as a reference point, insofar as the European institution appears to be effective.<sup>4</sup>

The research questions considered in this paper are as follows:

- Do twins (equivalents) of litigated US patents fare better or worse in the examination phase of the European patent system than suitably defined control-group patents? In other words, does European examination detect and exclude contested patents in the early phase of the patent granting process?
- To what extent is the European equivalent of a litigated U.S. patent more likely to be involved in an opposition proceeding than a suitably defined control group patent?
- Are equivalents of US litigated patents more likely to be revoked or narrowed in opposition proceedings than suitably defined control group patents?
- Given our empirical findings, what are the cost/benefit implications to society of the adoption of a post-grant administrative proceeding in the United States?

In answering these questions, we focus first on the “twin relationship” or “equivalence” between European and US patents, thus identifying patents in the two jurisdictions that cover nearly identical inventions or technology disclosures. This relationship is defined by the congruence of the priority documents upon which the US and the European patent are based. We also usefully demonstrate in this paper the broader notion of a “family relationship” between national patents. This latter relationship encompasses some degree of relationship between the two underlying technologies, but does not require that the patents be strictly “equivalents,” i.e. congruence of priority documents of the respective patents. We discuss these distinctions in detail below, intending to contribute to a better understanding of international comparisons of patent systems. Clarifying and making use of the complex priority linkages between US and European patents is a novel contribution. To the best of our knowledge, no previous study has yet described, or made use of, these different relationships between national patents.

We find that EPO applications based on US-litigated patents have a higher grant rate at the EPO than the equivalents of non-litigated patents. Evidence suggests that owners of these patents are willing to compromise on the scope of their property rights in order to obtain a patent. In support, we find that the grant rates are higher and grant lags are longer. Examination-based statistics such as the number and types of (backward) patent references do not appear to distinguish strongly between the two groups. We confirm, however, that the equivalents of litigated patents are considerably more likely to be cited by subsequent patents. They are also more likely to constitute prior art that is considered harmful to the novelty claim of subsequent patents.

We also demonstrate an important difference in the opposition rates of litigated equivalents as compared to non-litigated control equivalents. This crucial difference arises in the increased likelihood of opposition in litigated and “twinned” U.S. patents: the opposition rate is approximately 20 per cent, and thus about three times higher for equivalents and “relatives” of litigated patents than for control group patents. Opposition outcomes are again largely non-discriminatory if we take effective results into account. Oppositions against the equivalents of

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<sup>4</sup> See Harhoff (2005) for a multivariate analysis of opposition and appeal at the EPO.

litigated patents are somewhat less successful than oppositions against control group patents. Moreover, it appears that owners of equivalents of litigated patents frequently withdraw their patents from the opposition process by letting the patent lapse, presumably in order to avoid an unfavorable opposition ruling. Owners of equivalents of U.S. litigated patents are also more likely to file an appeal against an unfavorable opposition outcome. This effect needs to be taken into account when considering the welfare impact of a future opposition system in the U.S.

Our results support the notion that the European system excludes equivalents of litigated US patents *due to an increased likelihood of opposition, and not by virtue of lower grant rates or less favorable opposition outcomes*. We argue that this finding has important policy implications in that it emphasizes the need for making opposition proceedings affordable and accessible to any party with information regarding a patent's (in)validity.

At the very core of our study is a conceptual question: to what extent would a post-grant review mechanism at the USPTO improve welfare? Two possible effects are considered. First, we consider that post-grant review would introduce a mechanism that would allow some questionable patents to be revoked or narrowed at an early stage, thus reducing the likelihood of these becoming expensive litigation cases. Second, we consider that a post-grant review system may generate benefits by revoking patents that do not now enter subsequent litigation, but without review are generating welfare losses due to excessive market power. In a high-cost litigation system such as the United States, such patents may never be challenged because obtaining a license, or finding a “work-around” to the patent, is preferred by competitors to challenging the patent's validity (even if its validity is questionable). Building on earlier work in Hall et al (2003), but using our own estimates of opposition likelihood and outcome distributions, we present several calculations of welfare benefits that summarize the impact of post-grant reviews. Our results confirm the idea that introducing a low-cost post-grant review mechanisms would allow for large welfare gains. Typical benefit-cost ratios are on the order of ten and higher according to these calculations.

The remainder of the paper is organized as follows. Section 2 offers information of the institutional background of this study, both in terms of U.S. litigation and EPO opposition proceedings. Section 3 follows with a discussion of data issues, demonstrating our techniques for collection and analysis of U.S. patent litigation and the construction of a control group of patents. We also document in this section patent characteristics, the opposition frequency, and outcomes of opposition proceedings for “twins” of patents litigated in the U.S. and for the respective control group. In section 4, we use these statistics to provide an estimate of the welfare effects that could be expected from the introduction of a post-grant review system in the U.S. Section 5 summarizes our results and concludes.

## **2 Institutional Background**

### **2.1 Litigation in the U.S.**

In the United States, patent validity may be challenged post-grant in two forums: within the administrative agency (USPTO) or in the judicial branch (courts). The administrative process most often used, the *reexamination*, is *ex parte* (giving the patentee exclusive rights to communication with the agency) and restricts the involvement of the challenger to providing notice of challenge with only certain types of evidence. Graham et al. (2003) document the limited use, and usefulness, of the U.S. reexamination proceeding, showing that only 0.3% of

patents granted between 1991 and 1998 were reexamined, and that almost half of these reexamination requests were initiated by the patent owner. A refinement of the procedure introduced in 1999, the *inter partes* reexamination, allows challengers more access, but creates such substantial disincentives to challengers that it is far less used in practice (Farrell and Merges, 2004). As a result, litigation in the U.S. Federal courts is the only meaningful mechanism available for affected parties to challenge the validity of a patent issued by the USPTO. And, as we will make plain, it is an extremely costly mechanism for parties to access.

Procedurally, patent litigation is a full-blown adversarial proceeding in the U.S. federal courts. Activities include, but are not limited to investigation, preparing or answering the complaint and other documents, seeking to impose or prevent an injunction, preparing expert witnesses, engaging in pre-trial discovery, jury selection, preparing demonstrative and human evidence, and trial. Patent suits may arise from either infringement actions by the patentee, or "declaratory judgment" suits by a competitor seeking to invalidate the owner's patent in the courts. Challengers are restricted in their ability to bring this latter type of case: in order to file such an action, there must be either an explicit threat or other action by the patentee that creates a "reasonable apprehension" on the part of the challenger that it will face an infringement suit.

The patent owner enjoys several strong advantages in federal lawsuits. First, courts consider that a U.S. patent is "born valid," and place the legal burden on challengers to prove patent invalidity. Second, the burden of persuasion on the challenger is the heightened "clear and convincing" standard, a burden substantially higher than the mere "preponderance of the evidence" standard that is the rule in most civil proceedings.<sup>5</sup> The costs that these burdens and barriers impose upon challengers are heightened because, in many circumstances, judges and juries have limited science and engineering training. Judicial philosophy creates added costs: Lemley and Allison (1998) demonstrate that during the years after the creation of the specialized patent appellate court (the Court of Appeals for the Federal Circuit, created in 1983), the rate of successful patent challenges fell from 50 percent to 33 percent.

The patentee also enjoys timing and siting advantages over challengers in federal courts. In the case of an infringement lawsuit, the patent owner exerts *de facto* and *de jure* control over the timing of enforcement and litigation of the patent dispute. In infringement actions, the patentee also has first choice of geographic venue, an important consideration when one considers the heterogeneity in decisionmaking displayed by judges and juries in the 94 different district courts across the United States. But even in "declaratory judgment" suits brought by challengers, the patentee exerts considerable control over timing. Because the competitor must have a reasonable apprehension of an infringement action, such apprehension generally comes in the form of a demand from the patentee to cease infringement: thus the patentee's role in choosing the time to commence a dispute is plain.

Direct legal costs of a typical patent lawsuit are estimated to be \$4 million U.S. (AIPLA, 2003), although Farrell and Merges (2004) show that, as more money is at risk in the suit, litigation costs rise sharply--mostly driven by discretionary spending. Another estimate puts the costs in patent litigation at \$500,000 U.S. per claim at issue, per side (Barton, 2000).

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<sup>5</sup> Jolls, Sunstein, and Thaler quote a survey of federal judges who report that the preponderance standard is 50% while the "clear and convincing" standard requires proof to a 60-70% certainty. C. Jolls, C.R. Sunstein, and R. Thaler (1998). "A Behavioral Approach to Law and Economics," *Stanford Law Review*, May: 1530-1531.

While it has been shown that about 95 percent of patent suits end in settlement (Lanjouw and Schankerman, 2001b), settlement in the shadow of litigation is nonetheless time consuming and expensive. Lanjouw and Schankerman (2001b) estimate time to settlement at 8 to 25 months, while trials taken to completion are estimated to last 31 months (Magrab, 1993). Because surveys conducted by the AIPLA report that approximately half the estimated legal costs of litigation are incurred before the end of the discovery phase (AIPLA, 2001), litigation events, even if they end in settlement, involve substantial direct costs.

In sum, litigation in the U.S. federal courts is burdensome, both in terms of legal barriers and direct and indirect costs, to a potential challenger. These costs create a substantial disincentive for challengers, particularly when resource constrained. Farrell and Merges (2004) stress that federal court challenges are also less likely because of public goods and pass through problems: The former is a coordination problem that creates advantages to free riding, with the result that none file suit, while the latter results from the ability of competitors to pass through to consumers the costs the patentees demands for royalties, without regard to the validity of the patentee's claims. Both create disincentives to challenge invalid patents, with substantial welfare loss. The post-grant review has been advocated as a solution to the resulting decreased likelihood of the legal system ferreting out poor quality patents. Because these proposals are based in large part upon the experience of the European nations with "patent oppositions," we turn now to a discussion of the opposition proceedings available at the European Patent Office.

## **2.2 Opposition at the European Patent Office**

This section reviews the institutional setup of patent oppositions and appeals at the EPO. Patent protection for European member states can be obtained by filing several national applications at the respective national patent offices or by filing one EPO patent application at the European Patent Office. The EPO provides a supra-national application and granting procedure to its applicants. Patents granted by the EPO attain the same legal status as patents granted by the various national offices in the EPC signatory countries. Within nine months after the patent has been granted, any third party can oppose the European patent at the European Patent Office by filing an opposition against the granting decision. The outcome of the opposition procedure is binding for all states in which the patent granted by the EPO has effect. If opposition is not filed within nine months after the grant, the patent's validity can only be challenged under the legal rules of the respective countries in which the patent has been validated. The EPO opposition procedure is the only centralized challenge process for European patents. Opposition can be filed by any third party, but not by the proprietor of the patent.

Opposition may be filed on grounds listed in Art. 100 EPC. These are i) the subject matter is not patentable under the terms of the EPC Art. 52 to 57<sup>6</sup>, ii) the patent does not disclose the invention sufficiently clearly or completely so that it can be carried out by a person skilled in the art, or iii) the subject matter of the European patent extends beyond the content of the original application. The opposition is subject to a formal examination by a formalities officer

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<sup>6</sup> See EPC Art. 52-57. The invention is not patentable if a) the subject matter is not novel (Art. 52(1), 54 and 55 EPC), b) it does not involve an inventive step (Art. 52(1), 56 EPC), c) it cannot be used in an industrial application (Art. 52(1) and 57 EPC), and d) it is not regarded an invention (Art. 57 EPC) or is not patentable according to Art. 53 EPC.

in which it can be declared inadmissible if a formal requirement is violated. At the EPO, an Opposition Division determines the outcome of the opposition case.<sup>7</sup> The Opposition Division is a panel consisting of three technical examiners, two of whom must have taken no part in the proceedings for grant of the patent being opposed. The Opposition Division may be enlarged by adding a legally qualified examiner if the case requires legal expertise. The Opposition Division will attempt to come to a resolution of the case in written proceedings, and it may request as often as necessary written statements from the parties involved. Either the parties (i.e. the patent holder or any of the opponents) or third parties involved may request, or the Opposition Division may decide to hold, oral proceedings in accordance with Art. 116(1) EPC. The Opposition Division may decide to search for new prior art material upon its own initiative.

Opposition proceedings at the EPO may have one of four possible outcomes. First, according to Art. 102(1) EPC the patent may be upheld without amendments, i.e., the opposition is rejected. Second, the patent may be revoked according to Art. 102(1) EPC. Third, the patent may be maintained in amended form according to Art. 102(3) EPC. And fourth, the opposition procedure may be closed without directly observable outcome according to Rule 60(2).<sup>8</sup> The latter outcome may occur if the opposition is withdrawn or if the patent lapses. If the patent has lapsed in all EPC states in which it had effect after the grant, the opponent can request continuation of the opposition proceedings according to Rule 60(1). If the opponent does not pursue this right, the opposition will be closed. Thus, the interpretation of this outcome “opposition closed” is ambiguous *ex ante*, and we resort to determine its meaning empirically by looking at renewal data. If patent renewal fees are being paid after the opposition has been closed, it is likely that the opponent has withdrawn. If the payment of renewal fees ceases prior to the closing of opposition or just after the opposition has been filed, it is likely that the proprietor has allowed the patent to lapse. The latter case (withdrawal by patent proprietor) appears to be about three times more likely than the former in which the opponent withdraws.

Another interesting aspect of the opposition procedure concerns the restrictions imposed by this process on the opponent’s ability to settle “out of court”. Once an opposition is filed, the EPO can choose to pursue the case on its own, even if the opposition is withdrawn.<sup>9</sup> Thus, the opponent and patentholder may not be free to settle their case outside of the EPO opposition process once the opposition is filed. This provision of the opposition proceeding is likely to discourage its use by opponents seeking to force patentholders to license their patents.

Both the patentholder(s) and the opponent(s) may appeal the outcome of the opposition procedure.<sup>10</sup> The appeal must be filed within two months after receipt of the decision of the opposition division, and it must be substantiated within an additional two months. The Board of Appeal affords the final opportunity at the EPO to test the validity of the contested European patent. Both parties can bring expert witnesses into the proceedings, and there are various options for having deadlines extended.

The costs of opposition and appeal are typically born by each party. However, the opposition division may deviate from this cost allocation under certain circumstances detailed in Art. 104

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<sup>7</sup> See EPO (2003, Part D, Chapter VI).

<sup>8</sup> See EPC (2003, Part D, Chapter VIII).

<sup>9</sup> Rule 60 EPC: “In the event of the death or legal incapacity of an opponent, the opposition proceedings may be continued by the European Patent Office of its own motion, even without the participation of the heirs or legal representatives. The same shall apply when the opposition is withdrawn.”

<sup>10</sup> Article 99ff. EPC

EPC, in particular for “reasons of equity.” According to EPO (2003, Part D, Chapter IX, 1.4) the principle of equity applies when “the costs are culpably incurred as a result of irresponsible or even malicious actions.” The costs can then be charged to the party responsible. Discussions with EPO staff indicate that this option is rarely used, so that in the vast majority of cases, the costs are born by each of the parties themselves. The official fee for filing an opposition is 613€; for filing an appeal against the outcome of opposition, the fee is 1,022€. But the total costs to the opponent or the patentholder are much higher. Estimates by patent attorneys of the costs of an opposition range between 10,000€ and 25,000€ for each party.<sup>11</sup> Patent attorneys interviewed by us agreed that there is not much room for the opponent to drive up the patent owner’s cost of litigation, for two reasons: i) attorney fees are regulated in most European countries, including Germany, where many patent lawyers who have the required EPO registration reside; ii) the institution of discovery, a main cause of the large cost of U.S. litigation, does not exist in the EPO opposition system. Note also that the apportionment rule of Art. 104 EPC should also serve to discourage attempts to drive up the other party’s costs. In conclusion, the European institution has three important advantages in comparison to U.S. litigation – it is considerably less costly; opportunities for strategic manipulation of an adversary’s costs are restricted to a large extent; and restrictions on settlement make opposition unattractive as an instrument to extort payments from the patent holder.

### **3 Data Issues and Empirical Results**

#### **3.1 Identification of Litigated US Patents - Sampling and Validation**

Information on the litigation history of United States patents has been remarkably difficult to collect. This difficulty is all the more vexing when one considers the importance of patent litigation in the United States. As outlined above, it offers the only effective *ex post* mechanism available to challenge the validity of granted patents. Lack of data has substantially reduced the ability of researchers to empirically study questions related to patent litigation, and to the testing of patent validity more generally (Hall et al., 2004). While there are notable exceptions in the literature (Lanjouw and Schankerman, 2001; Somaya 2002), studies have nevertheless been few given the importance of the subject matter.

Our study makes use of litigation data collected from the Westlaw™ database that includes patent suits reported to the United States Patent and Trademark Office by the U.S. District Courts since 1973. We supplement these data with information supplied to the Federal Judicial Center by U.S. courts made available through the Inter-University Consortium for Political and Social Research. Our data contain over 32,000 individual litigation records and match to over 25,500 US patents issued between 1963-2003.

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<sup>11</sup> Mewburn Ellis LLP (<http://www.mewburn.com/meepopf.htm>, June 30<sup>th</sup>, 2004) give ranges between \$5,000 and \$15,000 to prepare and file a Notice of Opposition for standard cases, and between \$8,000 and \$30,000 for the subsequent correspondence and oral proceeding. Markus Herzog of Weickmann & Weickmann, Munich, estimates the cost for each side to be €7,000 for the opposition and €10,000 for the appeal stage if the parties employ patent attorneys at the EPO’s location (i.e., without cost of travel). E-mail communication with Markus Herzog, Partner, Weickmann & Weickmann (Oct. 17, 2001). He also notes that the parties have virtually no way of driving up their adversary’s costs. In an updated interview with Markus Herzog on March 10, 2005, he put the costs of opposition in a range of €10,000 - €15,000.



As a validity check, we benchmarked our data against the results reported from data used in two prominent studies of patent litigation (Somaya 2002; Lanjouw and Schankerman, 2001), datasets reported by the authors as reasonably comprehensive representations of patent litigation in the United States. Our Figure 1 demonstrates that the sheer number of patents litigated has been growing steadily since the 1960s, but has not appeared to change markedly as a share of applications filed. As such, our data demonstrate a pattern roughly consistent with data presented in Somaya (2002),<sup>12</sup> although our data shows two important differences. First, our data are more complete in the later years, a consequence of the lagged nature of litigation events (we collected our data in 2005 while Somaya collected data in 1999-2000 for the 2002 paper). Second, our data appear to be more comprehensive in the early years. This finding is not necessarily inconsistent with Somaya's findings, in that he reports, and analyzes throughout the article, cases filed per patent while we report litigated patents (by application year). Thus, the underreporting of cases by the District Courts to the USPTO that Somaya cites in his article in the early years of his study (prior to 1983) is unlikely to have as marked an impact on patents in the earliest years of our sample (prior to 1975) because we are matching on application date and there exist long lags between patent application and patent litigation. Another explanation may be that our data is in fact more comprehensive in these early years: Westlaw™ announces that its litigation data is supplemented--which may indicate that it has found a source for these "missing" data.<sup>13</sup>

**[Figure 1 about here]**

We also benchmarked our data against statistics reported by Lanjouw and Schankerman (2001). Our Figure 2 demonstrates that the litigation rate for granted patents year-on-year (based on application year) fluctuates between 6.8 per thousand and 9.5 per thousand from 1975-1995, with an apparent growth in litigation rates through 1995 until right censoring becomes apparent in the statistics for years after 1995. These figures are roughly consistent with statistics detailed by Lanjouw and Schankerman, who report 10.7 cases *filed* per thousand patents 1980-84, and 6.3 patents per thousand that show a litigation event in their lifetime. Our figure for the same time period (1980-84), by application year, is 8.0 litigated patents per thousand. Our larger share may be the result of more cases having been revealed over time, or that our data are indeed more comprehensive as a result of data collection in the Westlaw™ database.<sup>14</sup>

**[Figure 2 about here]**

Lanjouw and Schankerman (2001) also report statistics for litigation in broad technology classes, and compare the characteristics of litigated and non-litigated patents, thus allowing us to further benchmark our data. We summarize their findings, and ours, in Table 1, in which we apply the same technology-class and application-year definitions used in Lanjouw and Schankerman to our data.<sup>15</sup> The table demonstrates that the technology field effects for cases

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<sup>12</sup> Somaya reports cases filed from 1975-95 (Somaya, 2002: Figure 1).

<sup>13</sup> "The LITALERT (Patent and Trademark Litigation Alert) database contains records for patent and trademark litigation lawsuits filed in ninety-four U.S. District courts that have been reported to the Commissioner of the United States Patent and Trademark Office (USPTO). Also included are records for thousands of lawsuits filed since the early 1970's that have never been published in the Official Gazette." Westlaw.com.

<sup>14</sup> Ibid.

<sup>15</sup> "The IPC [international patent class] categories included in each of these groups are: Drugs and Health: A61 and A01N; Chemical: A62, B31, C01-C20, D-; Electronic: G01-G21, H-; Mechanical: B21-B68 not including B31, C21-C30, E01-F40." Lanjouw and Schankerman (2001), Table 1. They use patents with

filed per thousand patents and patents litigated per thousand (when the technology effects are compared to the sample mean) are roughly equivalent, and virtually identical when compared to the means in each sample. We surmise that differences reflect the fact that patents in these technology classes are more likely to be involved in multiple suit filings.

**[Table 1 about here]**

In sum, our Westlaw™ data appear to be a comprehensive sample of patents litigated in the United States 1963-2003, when one allows for the recorded underreporting of litigation events in the early years and right-side censoring due to patent cases having long lags when compared to patent application dates. Our data correspond reasonably well to the data used in earlier studies (Somaya, 2002; Lanjouw and Schankerman, 2001) and indeed appear more comprehensive in several respects. To the extent that our data more accurately reflect patents litigated in the U.S. during the 1990s to present, they are a more meaningful sample from which to draw conclusions about the effects of adopting a post-grant patent review in the United States.

### **3.2 Creating a Matched Sample of U.S. Patents**

This study compares European "equivalents" of litigated U.S. patents (see section 3.3 below) with European "equivalents" of non-litigated U.S. patents. Figure 3 summarizes our data collection strategy. While it is typical in empirical patent studies to create a matched sample on application date and technology class, there are assignee identity characteristics in our U.S. litigated patent sample that make a simple application year-technology class strategy inappropriate. Consistent with Lanjouw and Schankerman, our litigated patents are much more likely than the typical patent to be assigned to a domestic (U.S.) organization, and much less likely to be assigned to a foreign (non-U.S.) organization. For all patents, the likelihoods that a patent will be unassigned, assigned to a U.S. organization, or assigned to a non-U.S. organization are 18%, 47% and 33% respectively, while for our litigated sample the likelihoods are 25%, 62%, and 11%, respectively. To avoid selection problems born of assignee characteristics, we matched our sample on 4 bases: patent application year, 4-digit IPC technology class, nation of origin, and USPTO assignee code (1-7). Using this technique we were able to match approximately 98% of our U.S. litigated patents. For those unmatched patents, we used the application year-technology class method used previously (Graham et al. 2003).

**[Figure 3 about here]**

The advantage of using a sample of matching non-litigated U.S. patents and obtaining data on the respective equivalents is that this approach enables us to study differences in grant rates and in other procedural variables, such as time to grant, between equivalents of litigated and non-litigated U.S. patents. In particular, we can determine whether the owners of U.S. litigated patents are more likely to be denied European patent grants than owners of U.S. control group patents.

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application dates 1980-1984, as do we for this comparison, although we drop the very small number of patents issued after their original working-paper date of 1997 (0.02% of our sample).

### 3.3 Identification of Equivalents and Patent Families

We follow earlier work by Graham et al. (2003) in identifying foreign related patents of our sample of U.S.-granted patents. This earlier study exploited a relationship between U.S. and European (EPO) patents that can be best described as “family membership.”<sup>16</sup> Because the differences between “equivalent” and “family” patents in this context are import, we consider the issues in more detail here.

Strictly speaking, patents are highly unlikely to ever be *equivalent* since the national laws determining the legal rights bestowed on patent owners will differ even if patents have exactly the same wording. An applicant seeking patent protection in various jurisdictions is faced with different patent laws and procedural practices. If a U.S. patent applicant seeks to obtain a patent at the European Patent Office, she typically will use a somewhat modified version of the U.S. application and file this document within the priority year at the EPO or WIPO. If the applicant files a PCT application, the European Patent Office will typically be the target office for U.S. or international applicants. Both the U.S. application and the EPO application may be based on priority documents different than the patent application itself.

Patent practitioners use at least three different classifications to characterize linkages between patent documents in different jurisdictions. When matching a U.S. patent to a non-U.S. patent, we will follow convention and refer to the non-U.S. patent matched under these different methods as an (1) equivalent, a (2) family patent, or an (3) extended family patent. Figure 4 explains our approach, and follows from discussions with and information provided by the EPO (2005).

[Figure 4 about here]

As our most conservative identification method, we will call the patents “equivalents” if they share exactly the same set of priority documents. Given a group of patents that share some priority documents (D1-D5 in Figure 4), only those that share *exactly the same* set of priority documents would be considered “equivalents” for our analysis. In Figure 4, only two patent documents (D2 and D3) are equivalents because they are based on exactly the same set of priority documents (P1 and P2). None of the other documents are equivalent with any other in the set.<sup>17</sup> In our study, D2 could be a US patent document while D3 could be an EPO patent document. Since they refer to the same set of priorities, we can identify these two documents D2 and D3 as equivalents.

The identification methods used to collect a non-U.S. “family” patent and “extended family” patent of a U.S. document are less conservative than the “equivalent” approach in that we relax the requirement that exactly the same set of priority documents are required to find a match. In the case of a “family” patent of a U.S. document, documents are matched when they have at least one priority document in common. In Figure 4, documents D1, D2 and D3 form a patent family, since they have at least one priority in common (P1), while D2, D3 and

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<sup>16</sup> We referred to these patents in the earlier paper as equivalents, but we use a different notation here which is more consistent with patent attorney practice.

<sup>17</sup> We detail below that our matching the U.S. litigated patents to their European (EPO) equivalents produce a reasonably limited share of patent counterparts – approximately 18%. This figure differs substantially from the findings in Graham et al. (2003) where we used an extended definition of family relationship among patents. As we show later in this paper, although the definitions are quite different, very similar results with respect to the opposition propensity emerge.

D4 also form a family, as they have P2 in common, and D4 and D5 form a family based on the common priority P3.

In the case of an "extended family" patent of a U.S. document, matching is even less conservative - members of an extended family are defined as the set of documents linked either directly or indirectly through common priority documents. In Figure 4, all documents D1, D2, D3, D4 and D5 belong to the same "extended family" – they are linked directly and indirectly via the common priorities P1, P2 and P3. This definition is the least conservative because documents such as D5 and D3 (Figure 4) do not have a priority in common, but they are linked via document D4 and priority P2.

Information on European patents related to our given sets of U.S. patents was obtained from the ESPACE database. ESPACE explicitly lists equivalent patents and family patents as defined above. The latter definition is also used in INPADOC data (which are incorporated into ESPACE). For our analysis using extended patent families, we rely upon the OECD Triad Patent database to provide us with the non-US "extended family" patents for our U.S. documents. The Triad database is restricted to patent families that have family documents in all three major patent offices (EPO, JPO, and USPTO). Obtaining the members of the "extended family" without that restriction requires data on the priorities of US and EP patents which are difficult to obtain. A full match will however be provided in the near future.

A summary of the results of our matching using the three different methods is presented in Table 2. While we identified in the previous section a total of 25,482 litigated US patents, only patents with US filing dates after 1976 can have an EP equivalent. This leaves us with 18,033 litigated US utility patents and 18,033 matched US patents (obtained through stratified random sampling with replacement). Due to the replacement of sampled matched patents, our group of matched patents contains a small number of multiples.<sup>18</sup>

**[Table 2 about here]**

For the 18,033 granted and litigated U.S. patents, we were able to identify 3,416 equivalent EP applications. In some cases, a US patent would have several equivalents – the 3,416 EP patent applications are related to 3,342 non-identical US patents. For the 18,033 granted and matched U.S. patents, we identified 3,335 equivalent EP applications (equivalents for 3,295 US patents). Thus, the likelihood of finding one or more equivalents is only slightly higher for the presumably more valuable group of litigated patents. For both groups, the probability of finding an equivalent is quite low (18.5 percent for litigated and 18.3 percent for control group patents).

Generating a control group of US patents allows us to study more than just the workings of the opposition procedure. In particular, we can observe if litigated and non-litigated patents have the same likelihood of having an equivalent (or related family members). But being able to do so comes at a cost: it is important to note that while we have matched the U.S. patent pairs with EP patent applications, we do not necessarily have corresponding EP application pairs (nor pairs of granted patents) for all US pairs.

These differences are important for the interpretation of our descriptive statistics. For the purpose of our comparisons, we have to distinguish between four types of equivalent EP patent applications: 1) EP patent applications that are equivalents to US litigated patents, but

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<sup>18</sup> There are 104 duplicates, 2 triplicates and 2 quadruples.

without a paired EP patent application that is equivalent to the (paired) US non-litigated patent; 2) applications equivalent to US litigated patents for which an equivalent to the (paired) US non-litigated patent exists; 3) the group of applications being equivalent to US control group patents and having matching EP observations in group 2); 4) a group of EP applications equivalent to US control group patents, but without a matching EP equivalent to the paired litigated patent. It is clear that groups 2) and 3) allow for the most reliable controlled comparison, but the matched pairs in this comparison are the result of consecutive selection effects. In particular, we expect that patents in group 2) and 3) are more valuable than other patents as the likelihood of being in this sample is conditional on the existences of an equivalent for the litigated *and* the existence of an equivalent of the control group patent. This probability is particularly high in technical fields with above-average patent value where both US patents are taken abroad to obtain patent protection in Europe.

Table 2 also lists the numbers of EPO documents that are not equivalents, but are related to our U.S. litigated patents and the patents in the control group. Taking all “relatives” of our U.S. patents, we identify 7,789 EPO applications that are related to our 18,033 litigated patents, and 7,026 EPO “relatives” of our 18,033 (presumably) non-litigated patents of our control group. The ratio of identified EPO applications to US patent documents is higher for the litigated US patents (42.2%<sup>19</sup>) than for the control group patents (38.1%). This may simply reflect the fact that owners of more valuable patents (which are also more likely to be litigated) will tend to file more applications in support of a core invention than owners of less valuable patents.

Cognizant that our sample of litigated patents (N=18,033) differs in important characteristics from the population of all granted US patents, we also explored the hypothesis that our litigated-and-equivalent sub-sample (N=3,342) differs from the sample of litigated patents. We find that there are no meaningful differences in the distribution of primary international-patent classes.<sup>20</sup> In terms of assignee identity, the likelihoods that a litigated and equivalent patent will be unassigned, assigned to a U.S. organization, or assigned to a non-U.S. organization are 15%, 62% and 21% respectively. These shares more closely represent the overall population of granted patents in terms of unassigned and foreign organization-assigned patents than does the litigated sample, although the share of U.S. organization-assigned patents is substantially higher, in line with the litigated sample.<sup>21</sup>

### **3.4 Descriptive Statistics of U.S. Patents**

We test our priors concerning “value” correlates of U.S. patents by examining the number of claims, forward citations, and grant lags of both the (1) litigated sample and the (2) litigated sample for which we found EPO equivalents, comparing these against all U.S. patents with application dates after 1976. We note at the forefront that the incidence of litigation has been shown to be positively correlated with other indicators of patent “value.” Our number of

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<sup>19</sup> This figure is consistent with the Graham et al. (2003) findings for EPO matches to U.S. patents in pharmaceuticals, biotechnologies, semiconductors, and computers.

<sup>20</sup> Distributions for primary international classes A,B,C,D,E,F,G, and H are as follows, for Litigated sample and (Litigated & Equivalent sub-sample), in percents: 24.3(23.5); 22.2(21.3); 6.7(8.5); 1.0(1.1); 5.1(3.0); 7.8(6.4); 19.5(21.4); 13.4(14.8).

<sup>21</sup> In the overall population (and litigated sample), for unassigned, assigned to a U.S. organization, and assigned to a non-U.S. organization, respectively: 18%(25%); 47%(62%); and 33%(11%).

observations is somewhat smaller in these samples because full data on these characteristics was available only through 2002 grants. Our results are summarized in Table 3.

**[ Table 3 about here ]**

As we anticipated, the mean number of claims for litigated U.S. patents is significantly higher than for all U.S. patents. Moreover, the mean number of claims in litigated patents for which an EPO equivalent exists is again significantly higher than the sample of litigated patents. This finding suggests to us that, consistent with findings in Lanjouw and Schankerman (1997), the number of claims is a value correlate. The greater number of claims may signal, too, that patent applicants are engaged in more give-and-take effort with patent examiners, expending more effort to win “valuable” properties. Furthermore, consistent with our earlier findings, the likelihood of a U.S.-granted patent originating outside the U.S. is lower for litigated patents as compared to all granted patents, although it is interesting to note that this likelihood increases for patents that have an EPO equivalent.

Table 3 also contains information on the number of citations received by our U.S. patents. Our litigated patent sample shows a nearly three-fold increase in the number of forward citations as compared to all patents, and that factor rises to a more than four-fold increase when we compute the statistics for litigated patents for which an EPO equivalent exists. Both comparisons yield highly significant test results. These results suggest to us that both litigation, and the combination of litigation and seeking a patent in the EPO, are positive and significant value indicators for U.S. patents.

We also compute the likelihood that a patent applicant used the “continuation” procedure in the U.S. Patent Office, and the added associated grant lags. The continuation, essentially a procedural revision of a patent application that allows the applicant added time in examination, has been associated with secrecy strategies (Graham, 2004) and with other value correlates (Graham and Mowery, 2004). We find that continuations occur in approximately 22% of all patent applications, while about 37% of litigated patents tend to show a continuation application lineage. Interestingly, litigated patents for which there is an EPO equivalent are much less likely to issue after a continuation: only 11% of these patents show continuation process. We surmise that the rewards to continuation may be significantly blunted by the publication rules in Europe, although a complete explanation is beyond the scope of this paper.

Our results in Table 3 make it clear that calculating time from application to grant using the “application date” listed on the patent produces significant, but not large, differences between the samples. Consistent with findings in Graham (2004), using the first “continuation application” date to calculate grant lags in these U.S. patents yields much more substantial, and interesting, differences. For the litigated patent sample, continuation grant lags (3.14 years) are some 35 weeks longer than the mean for all patents (2.46 years). However, reflecting the reduced use of continuations among U.S. applicants also seeking EPO patents, grant lags are actually lower for these patents (2.23 years) than for all granted patents. The implications of these findings, and the insights they may offer to strategic international patent application procedures are beyond the scope of this paper, but demand further research. In sum, however, our findings support those of earlier research: litigated U.S. patents show in their manifest and latent characteristics added efforts by their applicants, and exhibit indications of value (Lanjouw and Schankerman, 2002; Hall, et al. 2004).

### **3.5 Examination and Opposition Process Outcomes for EP Relatives of US Litigated and US Control Group Patents**

Table 4 presents a first set of comparisons between EPO patent applications. The four columns represent the different groups of equivalent applications just described. In the subsequent discussion, we first focus on the comparison of columns 2 and 3. The comparison of unpaired equivalents in groups 1 and 4 confirms our results, but due to differential selection effects the statistics differ between group 1 and 2, and group 3 and 4, respectively.

**[Table 4 about here]**

We first study the examination outcomes in Europe. We find that the EP grant rate is considerably *higher* for the equivalents of litigated patents than for twins of the control groups. In our paired comparison, 80.3 percent of equivalents of litigated patents achieve a patent grant, 15 percent are withdrawn or refused, and 4.8 percent are still pending (column 3). The grant rate for equivalents of non-litigated US patents is 67.9 percent, 27.4 percent are withdrawn or refused, and 4.7 percent are still pending. In the unpaired comparison between columns 1 and 4, the grant rates are 68.9 and 59.9 percent, but about 9 percent of examination cases are still pending.

This finding confirms that the outcomes of patent examination cannot be taken as a simple indicator of patent quality. The decision to pursue an application is the result of complex tradeoffs between patent scope and patent value. For an economically important invention, a patent holder may be willing to accept even an highly restricted patent (low scope) while for an economically unimportant one, the patent holder would simply withdraw the application.<sup>22</sup> Applicants with valuable patents can be expected to put more effort into securing a patent grant (even if the claims are narrowed by the examiner during the give-and-take of the examination process). For our control group, the grant of a narrowed version may no longer be attractive and thus applicants may be more willing to abandon the prosecution instead of expending more resources in the patent-seeking process.

Table 4 also contains information about a number of application characteristics. When compared to the equivalents of control-group patents, equivalents of litigated patents typically contain more claims and the search reports associated with these applications subsequently have a larger number of references to earlier patents. The search reports for equivalents of litigated patents also indicate a somewhat larger share of critical references of the X or Y type than for equivalents of control group patents. These designations indicate that the search examiner at the EPO has found more damaging state of the art. However, the differences are small and not always significant.

When we consider the number of citations received by our equivalents, it is clear that equivalents of litigated patents (in columns 1 and 2) have about twice the number of citations than equivalents of non-litigated patents (in columns 3 and 4). Both comparisons yield highly significant test results. Moreover, the classification in the citing search reports indicates that

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<sup>22</sup> Discussions with German patent attorneys confirm this view. “Examiners may be uninformed, or too generous. Patent applicants can make it very difficult for examiners to say ‘No.’ I have seen incidents in which an examiner wants to refuse an application, but the applicant arranges a meeting with attorneys and technical experts – and the examiner is put under pressure and in the end allows the patent. The patent may not be what the applicant wanted, but the applicant gets a patent nevertheless.” Interview with Dr. Michael Wallinger, March 8, 2005.

equivalents of litigated patents are likely to establish higher hurdles for subsequent applications than equivalents of control group patents do. The share of X citations is significantly higher in column 2 than in column 3. The other comparisons (columns 1 and 4 for share of X citations, and both comparisons for the share of Y citations) do not indicate significant differences.

To summarize, Table 4 yields strong evidence that equivalents of litigated patents fare well in the examination process at the EPO. This is not evidence that the examination process does not discriminate at all in the sense that it does not detect the controversial nature of equivalents that are being litigated in the US.

We continue our exploratory analysis by restricting attention to patent applications that yielded an actual patent grant. Table 5 mimics the structure of Table 4 in that the inner columns 2 and 3 allow again for a paired comparison while statistics for the unpaired cases are displayed in the outer columns 1 and 4. Our focus is here on the likelihood of opposition and on opposition outcomes.

### **[Table 5 about here]**

Given the higher grant rate for equivalents of litigated US patents, it is not surprising that the number of observations in column 1 is considerably larger than the size of the corresponding group in column 4. Our first result is that the time to grant (or grant lag) is significantly higher for the equivalents of litigated US patents. However, in the most reliable paired comparison, the difference is fairly small (0.14 years).

The most pronounced difference can be found in the opposition frequency statistic. Equivalents of litigated patents are about three times more likely than equivalents of non-litigated patents to be challenged under opposition. From our descriptive statistics, we cannot determine at this point whether the increased attack rate is due to the (presumed) higher value of patents represented in columns 1 and 2, or to the perception on the part of the challenger(s) that the targeted patent may be a particularly easy one to challenge (i.e., promises a high success rate).

Our outcome statistics help us to illuminate this question to some degree. Note first that the share of pending opposition cases is higher for the equivalents of litigated patents. Taking columns 2 and 3 as the basis of our comparison, we note that the grant lag did not differ substantially, and yet the construction of our pairs should adequately control for application year effects. Hence, the opposition proceedings for the patents described in column 2 appear to consume more time than for those described in column 3. Again, this finding is likely the result of endogenous effort allocation – parties will fight harder to maintain or destroy particularly valuable patent rights. However, we can show that neglecting pending cases is harmless.<sup>23</sup>

Considering the distribution of outcomes, we find one unexpected result in Table 4. A surprisingly large number of cases among opposed equivalents of litigated US patents end up with the opposition being closed, i.e., abandoned (14.7 percent in column 1 and 13.0 percent in column 2). The respective comparison figures are significantly smaller, and so is the share of this outcome in the population of opposition cases (5.3 percent, see Hall and Harhoff 2004,

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<sup>23</sup> When we restrict the data to include application years prior to 1990, the share of pending cases is almost zero, but the distribution of outcomes remains stable.



Table 2). Between 22.6 and 24.4 percent of litigation cases yield a revocation of the equivalent EPO patent, while the revocation rate is between 39.5 and 27.6 percent for control group cases. A naive interpretation of these data would imply that the revocation rate is significantly lower for the litigation group of equivalents. However, these "closed" cases may include those in which either the opponent withdrew from the proceedings or the patent-holder withdrew (for example, by no longer paying renewal fees).

In order to explore this hypothesis, we investigate these cases in more detail and assigned each "closed" case to either a "rejection" (in cases where the opponent withdrew) or to "revocations" (when the patent holder allowed the patent to lapse). We assign a patent to a "patent revoked or lapsed" outcome whenever we find no evidence that an equivalent was validated by a national office in any of the designated states. Conversely, we assign the outcome "opposition rejected or withdrawn" if the patent was validated and renewal fees were paid at any of the national offices. The results of an analysis of these reclassifications are shown in Table 5.

Analysis after reclassification demonstrates that the revocation rates are now roughly equal between the equivalents of the litigated and control sample. Nevertheless, more cases are amended for equivalents of litigated patents than for those of matched patents in column 2 and 3, and the litigation group has a somewhat lower revocation rate. One possible explanation of this finding is that patent-holders are seeking to maintain their "valuable" patents, even in a more narrowed form. One explanation for the increased share of "opposition closed" outcomes for matches to litigated patents is that patent holders seek to avoid an official invalidation by the EPO and prefer to drop the matter by allowing the patent right to instead lapse.

The hypothesis that owners of litigated US patents exert considerable effort to keep their IP rights in force is also demonstrated by the difference in appeal rates. In 52.0 percent of all opposition cases targeting EP equivalents of litigated US patents (weighted average of 50.7 and 55.6 percent in columns 1 and 2), the patent owner appeals the outcome. We find that only one third of all cases concerning equivalents of matched US patents enter an appeal phase (42.9 percent in column 3 and 26.9 percent in column 4, yielding a weighted rate of 32.5 percent).

Neglecting the differences between paired and unpaired EP equivalents, we present in Figure 5 a graphical depiction of the differences between opposition rates for the EP equivalents of U.S. litigated patents and equivalents for the control group. Cases pending in examination were excluded. While the overall opposition rate for the matches to U.S. litigated patents is declining over time, the trend clearly shows that the opposition rate for equivalents of U.S. litigated patents dominates that of the equivalents of the control sample throughout 1981-2001.

[Figure 5 about here]

### **3.6 Examination and Opposition Process Outcomes for EP Relatives of US Litigated Patents and for EP Control Group Patents**

An alternative to matching U.S. litigated patents with non-litigated U.S. patents would be to create a match between equivalents of U.S. litigated patents and suitably defined EPO. The advantage of this approach is that it conditions on characteristics of the European relatives of

the US litigated patents. Hence, the differential selection effects that make the statistics in Table 5 and Table 4 hard to interpret would not disturb the comparison.

To proceed along these lines, we maintained all unique relatives (3,403 equivalents, 1,248 family members and 3,138 members of the extended family) of our 18,033 US litigated patents. Using the population of EPO applications, we performed a random sampling of control patents (with replacement) using priority year, priority country, technology field and grant status as conditioning variables. Due to some missing data, we are only able to include 3,386 equivalents (instead of 3,403) of US litigated patents and their EP control group as well as 4,286 non-equivalent family members (instead of 4,386) of US litigated patents and their EP control group in the comparison. The descriptive statistics are summarized in Table 6.

### **[Table 6 about here]**

This comparison provides a robustness check for the earlier results. The main insights from the comparison of the data in Table 5 and Table 4 are confirmed. EPO applications related to litigated patents are broader in scope (have more claims), contain more references to earlier patents, receive more citations from subsequent patents and establish higher hurdles for later filings than EP applications matched using the procedure described above.

More importantly, these patents take longer to achieve a patent grant. They have an opposition rate that is about three times higher than in the control group, and the share of opposition cases effectively leading to revocation is slightly lower than for the control group patents. These statistics support our hypothesis that holders of US patents litigated in the US may be exerting more effort to win a patent at the EPO. Moreover, opponents attack these patents even in the face of somewhat reduced chances of success. Finally, we confirm that the appeal rate for EP “incarnations” of US litigated patents is significantly higher than for control group patents.<sup>24</sup> Thus, our main results hold irrespective of the chosen control group design.

## **4 Empirical Implications**

Our findings strongly suggest that U.S. litigated patents are more likely than are “average” patents to be candidates for post-grant review in jurisdictions where that review is available. We note again that the comparison is conservative as the European examination procedures are less permissive than those in the U.S. patent system—upwards of 20 per cent of U.S. litigated patents, and 30 per cent of non-litigated patents, are never awarded patent protection in Europe. Thus, we expect the twin of a U.S. litigated patent to have been screened more carefully than the corresponding U.S. patent. Our estimates of post-grant review likelihood are thus bound to be conservative, but a detailed assessment of the breadth and private value of these patents is currently beyond the scope of our paper. We expect the actual post-grant review frequency in the U.S. to be higher than in Europe as long as the respective costs are similar.

The social welfare implications associated with our findings are substantial. Even if we disregard the fact that EPO examination is resulting in a more precise delineation of patents

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<sup>24</sup> We also performed a comparison of non-equivalent family members of the US litigated and the US control group patents. We consider that test more difficult to interpret as we lose most of the matching structure. However, leaving this caveat aside, we obtain results that are very close to the ones summarized in Table 5.

rights (due to more strenuous examination), our findings show that roughly 19 to 24 percent (see Table 5) of the patents litigated in the U.S. are likely candidates for post-grant review, and that about one third of these would be revoked outright. The effective revocation rate is likely to be even higher: Conversations with German patent attorneys who both prosecute patents and contest oppositions suggest that approximately 50 percent of "partial revocations" result in a patent that is substantially damaged.<sup>25</sup> It thus appears that the mean impact of a "partial revocation" is likely to reduce the enforceability of the patent considerably. We suggest that the effect of the "partial revocation" would also lower the likelihood that such a patent could become a credible threat and would be used to initiate an infringement suit or to force competitors into socially inefficient "inventing-around" strategies. Our results allow us to generate some welfare calculations estimating the benefit that would flow to the United States from adopting a "post-grant review" procedure. While this exercise can by definition produce at best an estimate, we note that our calculation is based on underlying characteristics of the patent and that it is inherently conservative.

We propose to compute the welfare impact as follows. On the benefit side, we expect a reduction in the number of cases that will ultimately be litigated, because the post-grant review will act in many circumstances as a substitute for litigation. Hence, the litigation costs for these patents will be saved. Second, even if a patent is *not* litigated in the current U.S. system, under a new low-cost review system, some patents will be opposed and again (as we show for the group of twins of non-litigated US patents), about one third of these non-litigated patents will be revoked. We will assume that, absent post-grant review, allowing such patents to remain in force causes welfare losses, the result of excessive market power being allocated to the patent holder. Naturally, the cost of post-grant review must be taken into account as well.

Our first term, estimating the benefit from saved litigation expenses, can be written as follows. Let  $P$  be the number of patents granted in a given year and  $p_L$  is the probability of litigation in the current system. The probability of post-grant review for litigated patents is denoted  $p_{O,L}$ , and  $p_{R,L}$  is the probability of revocation of litigated patents in post-grant review. We will assume that 50 percent of the patents that are partially revoked are the equivalent of "revoked" patents, consistent with the testimony of experts in this field.  $p_{PR,L}$  is the probability of partial revocation in post-grant review for litigated patents. The average social cost of litigation is denoted  $S_L$ .

$$(1.1) \quad W_1 = p_L \cdot P \cdot p_{O,L} \cdot (p_{R,L} + 0.5p_{PR,L}) \cdot S_L$$

The computation of the welfare gain from revoking or partially revoking patents that bestow excessive market power on patent holders can be written as

$$(1.2) \quad W_2 = (1 - p_L) \cdot P \cdot p_{O,NL} \cdot (p_{R,NL} + 0.5p_{PR,NL}) \cdot S_{NL}$$

where  $p_{O,NL}$  is the probability of post-grant review for non-litigated patents,  $p_{R,NL}$  is the probability of revocation in post-grant review for non-litigated patents,  $p_{PR,NL}$  is the probability of partial revocation in post-grant review for non-litigated patents, and  $S_{NL}$  is the social cost originating from patent market power awarded in error.

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<sup>25</sup> The comments of one expert are representative of these opinions: "If 100 patents are opposed and all are adjudged as 'partially revoked,' approximately 25 will be left largely undamaged, 50 will have their validity substantially affected, and for 25 the result will be deadly." Interview with Dr. Michael Wallinger, March 8, 2005.

Finally, the cost of the post-grant review system can be written as

$$(1.3) \quad C = p_L \cdot P \cdot p_{O,L} \cdot (C_O + (p_{A,L} \cdot C_A)) + (1 - p_L) \cdot P \cdot p_{O,NL} \cdot (C_O + (p_{A,NL} \cdot C_A))$$

where  $p_{A,L}$  is the probability of appeal in post-grant review for litigated patents (conditional on post-grant review),  $p_{A,NL}$  is the probability of appeal in post-grant review for non-litigated patents (conditional on post-grant review),  $C_O$  is the average cost of post-grant review, and  $C_A$  denotes the average cost of appeal following a post-grant review.

These calculations of the potential societal savings from reducing litigation (1.1), the societal savings from reducing the maintenance of unwarranted patent monopolies (1.2), and the societal costs of running a post-grant review process (1.3) allow us to arrive at more precise estimates than have been available to date. We tabulate the results of our calculations in Table 7. All columns take the opposition and outcome frequencies from our findings presented in Table 5 (equivalents, outcome after reassignment of closings, weighted averages of columns (1) and (2) and columns (3) and (4)).

**[Table 7 about here]**

In our benchmark scenario 1, the estimate of the probability of litigation is taken from Allison et al. (2003) as 32 suits per 1000 patents. Alternatively, we use the more conservative probability given by Lanjouw and Schankerman (2001) as 10.1 cases per 1000 in our scenario 2. For the cost of litigation, we use the value of \$4 million as reported by the AIPLA (2003). As an alternative (and very conservative) assumption, we allow litigation costs to be as low as \$2 million. Hall et al. (2003) estimate a conservative average welfare loss of \$2 million for cases in which the patent is not litigated, but questionable. They employ value estimates from Harhoff, Scherer and Vopel (2003) for patents that survived opposition. They further assume linear demand and constant marginal costs, so that the welfare loss from monopoly power is equal to one half of the monopoly rents. In order to explore the sensitivity of our results we use two scenarios – one with a welfare loss of \$1 million and one with a welfare loss of \$4 million. In scenarios 1 and 2, we use the higher figure, in scenarios 3 and 4 we employ the more conservative estimate of \$1 million.

In order to obtain our estimates, we also have to make an assumption regarding the cost of post-grant review. Given that the likelihood of post-grant review and of appeal is likely to be a function of costs (assuming that the demand for post-grant review is elastic with respect to price), it would be unwise to deviate far from the actual cost situation at the EPO. Somewhat conservatively, we estimate the total opportunity cost of post-grant review to be \$50,000 US. For the appeal, we use the same figure that – in the case of the EPO – appears justified (see footnote 10). To demonstrate the impact of substantially higher costs, we allow the costs for both instances to be \$200,000 US in scenarios 7 and 8. Since these scenarios also use the lower bounds for litigation costs and social losses due to unwarranted, but unlitigated patents, the lowest benefit-cost ratios will show up in these “worst cases.”

When considering the outcomes summarized in Table 7, two results are particularly noteworthy. As in previous work described in Hall et al. (2003), the overall benefit cost ratios are sizeable and range between 4.0 and 31.2. We comment on the sensitivity of these estimates below. Second, and somewhat unexpected, a considerable share of the total net welfare gain  $W_{NET}$  comes from revocations in post-grant review of *currently non-litigated* patents. Given the high cost of litigation, a large number of patents that would be challenged in an inexpensive post-grant review system are not litigated in the current system. The presence of these patents is likely to have considerable negative welfare consequences,

insofar as they entitle the patent owner to excessive market power and trigger costly “invent-around” expenditures by competitors. A post-grant review system that offers low costs to the challenger would have a higher likelihood of identifying such patents, and our analysis shows that approximately one third of them will be revoked and one third substantially narrowed if the situation unfolds in a manner similar to the European setting.

Naturally, the above estimates hinge critically on a variety of assumptions. Moreover, simply transferring the empirical probabilities from Europe to the U.S. may not yield plausible results if the underlying cost structure and institutional setup of a future U.S. post-grant review system deviate strongly from this framework. However, as our results show, changes in the actual litigation rate in the U.S. does not change the results dramatically, since overall social benefit will be largely determined by the welfare effects emanating from those cases that are not being litigated under the current legal framework. This finding is an interesting aspect that has not been considered in detail in the current debate. One may argue that this result depends crucially on the assumed welfare loss from errant market power. While such an argument is doubtless correct, it is only when we assume an implausibly low welfare loss per case of non-litigated, but erroneously granted patent (with opposition in Europe) of \$590,000 (in scenario 1) and of \$280,000 (in scenario 2), respectively, that the two sources of welfare gains are on par with respect to their absolute net effects. Even in this case, the benefit-cost ratios for the overall post-grant review system would be at 7.4 (scenario 1 with litigation rate of 0.032) and 3.7 (scenario 2 with litigation rate of 0.010).

## 5 Discussion and Conclusions

Our paper is the first of which we are aware that compares U.S. *litigated* patents with their European "equivalent" patents. Our data collection, identification, and analysis enable us to draw some powerful conclusions about the propriety of adopting a patent "post-grant review" in the United States.

Our analysis suggests that even the most valuable U.S. patents, those that are inviting costly litigation in U.S. courts, are not being granted EPO patent protection in about 20 per cent of the cases. While some of this effect may be due to the different manner in which patentable subject matter is defined in the EPO (in software, for instance), higher quality standards at the EPO may also be playing a role. Our evidence thus lends support to proposals in the patent reform movement to provide funding and quality control to USPTO examination processes.

More provocatively, our analyses, and welfare calculations, suggest that the benefit from post-grant review in terms of social welfare per year—when put in dollar terms—could be over \$20 billion. The main parameter affecting this estimate is not the cost of litigation, but the social costs of currently unlitigated patents that bestow excessive market power on some applicants and either allow them to extort licensing fees, or force competitors to “invent around” the respective patent. But even when we draw a conservative scenario, and assume a very low social cost figure of \$1 million on average for these patents, our benefit-cost ratios still indicate that the benefits of such an institution compares very favourably to its costs.

Our calculations are based on reasonable estimates of the costs to parties of engaging in the post-grant review. While our estimates of these costs are predicated upon what we consider the best available proxy measure—the actual cost of European opposition proceedings—other commentators have used higher costs estimates. Levin and Levin (2003) use a figure of \$500,000, but admit that their figure is conservative (high) given that the average European

opposition costs considerably less. Given the high cost of legal process in the United States, however, we consider it necessary to make several points, and offer an important caveat. It is likely that any radical increase in the cost of post-grant review will alter our benefit calculations substantially (as shown in scenarios 7 and 8), not only by inflating the cost-side of the benefit equation, but also—to the extent that the demand for post-grant review is elastic with respect to price—by depressing the benefit that would flow from removing patents that bestow excessive market power. Several scenarios we have modelled demonstrate that radically higher post-grant review costs—on the order of the \$500,000 used by Levin and Levin—would result in a cost-benefit ratio near, and in some circumstances less than, unity. As demonstrated in Hall, et al. (2003), it is likely that any welfare benefits that flow to society will be quickly eroded by a high-cost post-grant review procedure.

Each of the major proposals for a post-grant review recognizes the importance of minimizing the costs to parties of using the procedure. Not only should the system avoid burdening a patentee with substantial costs, but also because the system is engineered to take advantage of knowledge that resides in the patentee's competitors about prior uses of the technology, the process should not erect cost barriers to them. This latter problem is particularly important given the "public good" nature of an invalidity decision: To the extent that the cost of such an invalidity outcome is increasing, the incentives for potential challengers to "free ride" increase, with the result that fewer worthy challenges will be brought.

Under U.S. law, the determinations of an administrative proceeding are due a review by the judicial branch, and thus the Court of Appeals for the Federal Circuit (CAFC) will likely play a role in controlling costs. Evidence suggests that the CAFC has not been deferential to the validity determinations of district court judges: while the reversal rates in the Courts of Appeal in all civil matters is approximately 10%, the CAFC reverses 50% of the district court validity decisions. This practice in the CAFC has the effect of shifting substantial costs to the litigating parties. An over-active reversal posture toward the determinations of post-grant review would have the effect of raising the costs of the process, thus eroding the welfare benefits we have demonstrated in our calculations.

Finally, our conversations with German patent attorneys allow us to shed some light on one of the more commonly raised arguments against the "post-grant review." It has been suggested that challengers will be reluctant to file post-grant reviews because to do so would invite retribution in the form of an infringement action by the patentee--the so-called "painting a big red target on yourself" argument. Leaving aside the fact that current proposals would allow challenges to be brought to the Patent Office through an intermediary, the consensus among the small sample of German attorneys we interviewed was that such outcomes did not occur. A cautionary warning came from their comments, however: one of the reasons given for this "signal" not being transmitted was that larger firms tend to file many oppositions. This implies that the information content of any one opposition may not be great. It was clear from their comments, however, that individuals and small firms--instead of being disadvantaged by an opposition system--are substantially advantaged. The much lower costs of purchasing a challenge is seen as a substantial benefit to smaller entities. Because the costs of litigation create a significant disincentive to small firms seeking invalidation in patent litigation (Lanjouw and Lerner, 1997), a post-grant review offers the prospect of helping, not harming, small entities on balance.

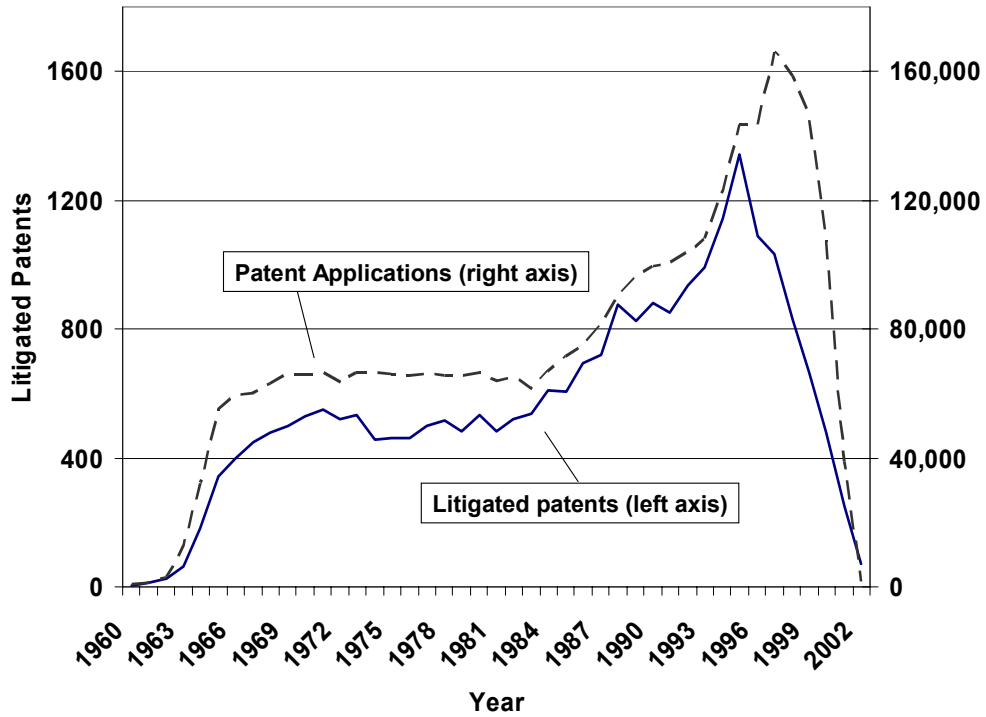
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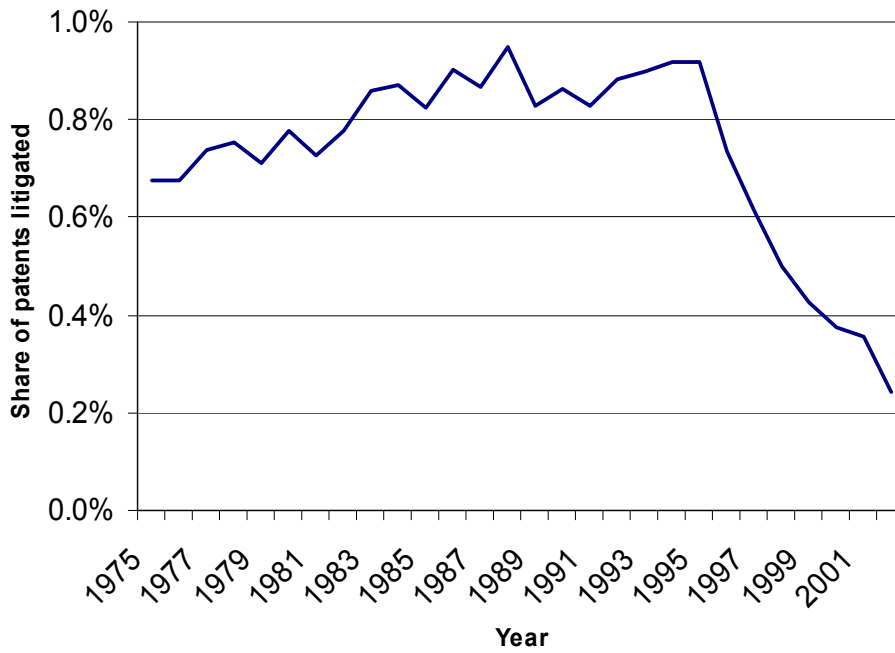
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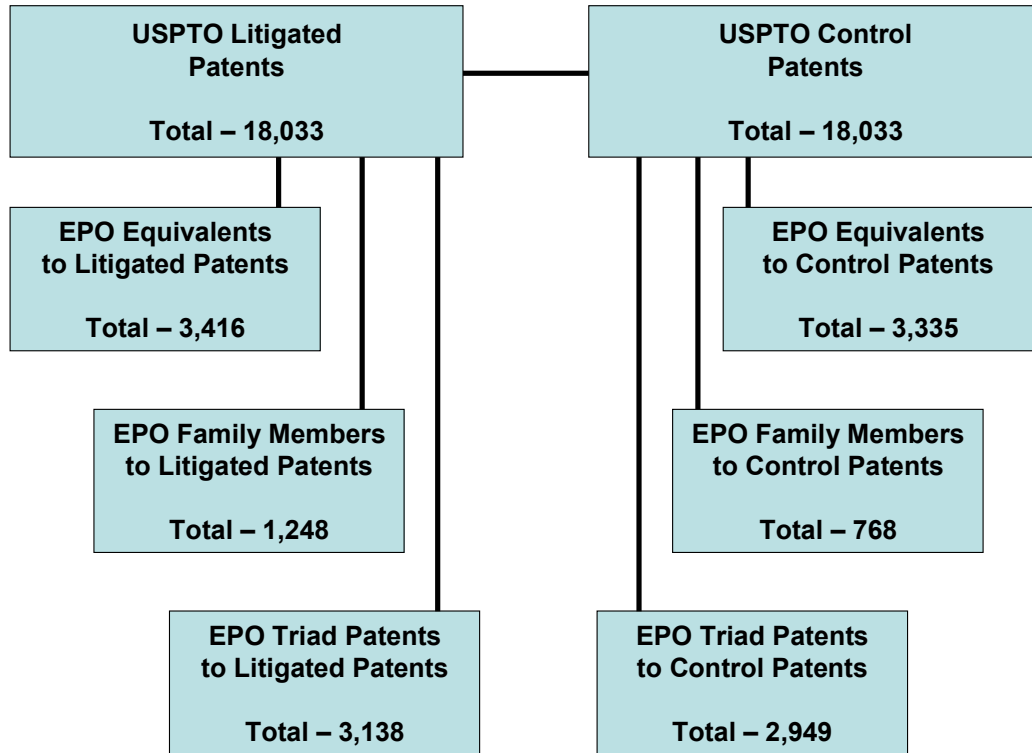
**Figure 1**  
 Comparison, U.S. Patent Applications, and  
 U.S. Litigated Patents, by application year



**Figure 2**  
 Patent Litigation Rate, by Application Year



**Figure 3**  
USPTO - EPO Sampling Strategy

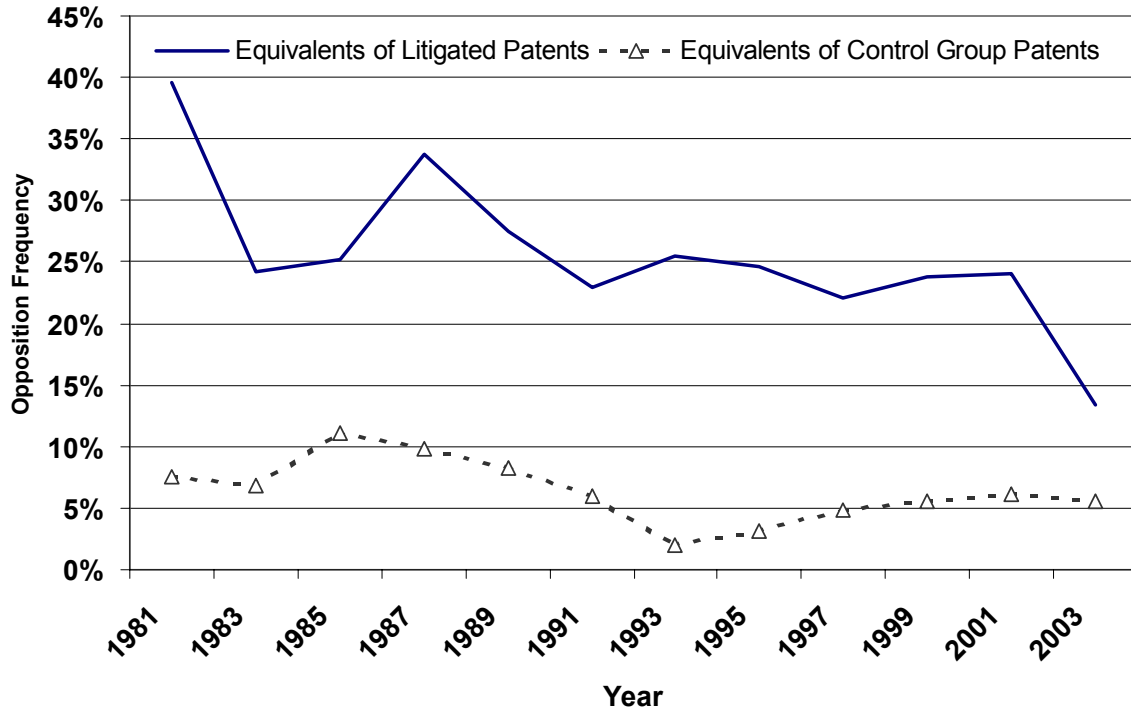


**Figure 4**  
Family Relationships between Patent Documents

<b>Document D1</b>	<b>Priority P1</b>		
<b>Document D2</b>	<b>Priority P1</b>	<b>Priority P2</b>	
<b>Document D3</b>	<b>Priority P1</b>	<b>Priority P2</b>	
<b>Document D4</b>		<b>Priority P2</b>	<b>Priority P3</b>
<b>Document D5</b>			<b>Priority P3</b>

**Figure 5**

EPO Opposition Frequency for Equivalents of Litigated and Control Group Patents



**Table 1**  
Comparison of Lanjouw & Schankerman (L&S)  
and Graham & Harhoff (G&H) Litigation Data

	L&S cases litigated 1980-84	share of sample mean	G&H patents 1980-84	share of sample mean
All sample mean	<b>10.7</b>	--	<b>8.0</b>	--
Drugs and health	20.1	1.9	14.1	1.8
Chemical	5.4	0.5	4.2	0.5
Electronics	9.6	0.9	7.7	1.0
Mechanical	11.8	1.1	8.4	1.1

Note: L&S data from Lanjouw and Schankerman (2001).

L&S: cases filed per thousand patents, application years 1980-1984

G&H: patents litigated per thousand patents, application years 1980-84.

**Table 2**  
Matching Results for US Litigated and Matching US Control Group Patents

	18,033 Litigated US Patents (application year 1977 or later)	18,033 Control Group Patents (application year 1977 or later)
EPO Equivalents Found	3,342 US patents (3,416 EPO applications)	3,295 US patents (3,335 EPO applications)
EPO Equivalents for Matching US Litigated <u>and</u> Control Group Patents	923 US patents (942 EPO applications)	923 US patents (942 EPO applications)
EPO Equivalents for Litigated US Patents Only	2,419 US patents (2,474 EPO applications)	0
EPO Equivalents for US Control Group Patents Only	0	2,372 US patents (2,393 EPO applications)
No EPO Equivalents	14,691 US patents	14,738 US patents
Unique EPO Related Patents	7,789	7,026
Unique EPO Equivalents	3,403	3,309
Unique EPO Family Patents	1,248	768
Unique EPO Extended Family Patents	3,138	2,949

**Table 3**  
Descriptive Statistics for U.S. Patents, Litigated U.S. Patents, and Litigated-Equivalent U.S. Patents

	(1)	(2)	(3)
	Test (1) vs. (2)	US Patents Litigated, application dates 1977-2002	US Patents Litigated, application dates 1977-2002
number of claims in patent*	<0.01	12.4 (0.01)	20.7 (0.44)
Percent of patents in which country of first inventor residence is U.S.	<0.01	54.7 (0.03)	73.8 (0.76)
US citations received through 2002*	<0.01	5.8 (0.01)	23.3 (0.73)
Percent of patents using continuation application process	<0.01	22.4 (0.02)	10.6 (0.53)
time to grant, application date (years)*	<0.01	1.98 (0.00)	2.09 (0.02)
time to grant, continuation date (years)*	<0.01	2.46 (0.00)	2.23 (0.02)
		N=2,377,094	N=17,794
			N=3,382

Source: Authors' computations from USPTO, Micropatent, and NBER data.

\* Mean value, standard errors in parentheses. Test results are obtained from simple t-tests or binomial tests (in the case of share variables).

**Table 4**  
Descriptive Statistics for EPO Equivalent Applications of  
Litigated and Non-Litigated USPTO Patents – Paired and Unpaired Comparisons

	Test (1) vs. (4)	Test (2) vs. (3)	(1) EPO equivalents of litigated US patents for matching unlitigated US patent	(2) EPO equivalents of litigated US patents and non-litigated US patent	(3) EPO equivalents of non-litigated US patents	(4) EPO equivalents of non-litigated US patents
equivalent EPO applications (US patents)	-	-	2,474 (2,419)	942 (923)	942 (923)	2,393 (2,372)
examination outcomes	-	-				
• application pending	-	-	9.5	4.8	4.7	8.6
• grant	-	-	68.9	80.3	67.9	59.9
• application withdrawn or consolidated	-	-	18.7	11.7	22.6	27.5
• grant effectively refused by EPO	-	-	3.0	3.3	4.8	4.1
number of claims in application*	<0.01	<0.01	18.32 (0.29)	16.48 (0.46)	13.67 (0.33)	15.61 (0.24)
number of references to other patents*	<0.01	<0.01	5.21 (0.07)	4.65 (0.10)	4.26 (0.09)	4.49 (0.06)
share of X references*	0.24	0.50	17.62 (0.54)	16.61 (0.86)	15.77 (0.90)	16.72 (0.56)
share of Y references*	0.02	0.52	15.26 (0.52)	13.45 (0.78)	12.72 (0.79)	13.62 (0.51)
EPO citations received within 5 yrs*	<0.01	<0.01	4.18 (0.11)	5.46 (0.22)	2.64 (0.11)	2.36 (0.07)
share of X citations received within 5 yrs*	0.17	<0.01	8.79 (0.41)	8.13 (0.57)	5.51 (0.53)	7.98 (0.44)
share of Y citations received within 5 yrs*	0.07	<0.11	6.59 (0.35)	6.17 (0.49)	5.02 (0.54)	5.70 (0.36)

Source: Authors' computations from ESPACE and EPOLINE data. Data on the number of claims was supplied by the EPO from its internal EPASYS database.

\* Mean value, standard errors in parentheses.

**Table 5**  
 Descriptive Statistics for EPO Equivalent Patent Grants of  
 Litigated and Non-Litigated USPTO Patents – Paired and Unpaired Comparisons

	(1) EPO equivalents of litigated US patents	(2) EPO equivalents of litigated US patents EPO equivalent for matched pairs of litigated and non-litigated US patent	(3) EPO equivalents of non-litigated US patents	(4) EPO equivalents of non-litigated US patents
equivalent EPO patent grants (US patents)	1,923 (1,873)	564 (548)	564 (548)	1,515 (1,497)
time to grant (years)	4.11 (0.05)	3.56 (0.08)	3.42 (0.08)	3.73 (0.05)
opposition rate	18.6	24.2	7.5	5.2
opposition pending	25.1	14.8	9.5	25.6
opposition outcomes (non-pending cases)				
• patent revoked	22.6	24.4	39.5	27.6
• opposition rejected	24.8	24.4	23.7	34.5
• patent amended	38.0	38.3	34.2	29.3
• opposition closed	14.7	13.0	2.6	8.6
opposition outcomes (consolidated)				
• patent revoked or lapsed	32.3	34.8	39.5	32.8
• opposition rejected or withdrawn	29.7	27.0	26.3	37.9
• patent amended	38.0	38.3	34.2	29.3
appeal rate	50.7	55.6	42.9	26.9

Source: Authors' computations from ESPACE and EPOLINE data. Data on the number of claims was supplied by the EPO from its internal EPASYS database.

\* Mean value, standard errors in parentheses.

**Table 6**  
Descriptive Statistics for EPO Equivalents and Non-Equivalent Family Members  
of Litigated U.S. Patents and for Matched EPO Patents

	Test (1) vs. (2)	(1) EPO equivalents of litigated US patents N=3,386	(2) EPO Patent Applications Matched to (1) N=3,386	Test (3) vs. (4)	(3) Non-equivalent EPO family members of litigated US patents N=4,286	(4) EPO Patent Applications Matched to (3) N=4,286
share of applications granted	-	72.1	72.1		57.2	57.2
share of applications pending	-	8.1	8.1		20.4	20.4
number of claims in application*	<0.01	17.8 (0.25)	15.0 (0.20)	<0.01	21.9 (0.33)	16.4 (0.20)
number of references to other patents*	<0.01	5.05 (0.06)	4.52 (0.05)	<0.01	4.89 (0.05)	4.26 (0.04)
share of X references*	0.51	17.39 (0.46)	16.94 (0.48)	<0.01	22.26 (0.46)	20.50 (0.46)
share of Y references*	0.01	14.77 (0.44)	13.27 (0.43)	<0.01	17.63 (0.43)	13.77 (0.39)
EPO citations received within 5 yrs*	<0.01	4.48 (0.10)	2.07 (0.05)	<0.01	3.08 (0.08)	2.07 (0.05)
share of X citations received within 5 yrs*	0.03	8.55 (0.34)	7.49 (0.34)	<0.01	11.09 (0.37)	9.36 (0.36)
share of Y citations received within 5 yrs*	<0.01	6.44 (0.29)	4.29 (0.27)	0.47	5.10 (0.24)	5.35 (0.26)
time to grant (years)*	<0.01	3.99 (0.04)	3.64 (0.040)	<0.01	5.35 (0.06)	3.96 (0.05)
opposition rate	<0.01	19.7	6.4	<0.01	22.3	6.4
opposition pending	<0.01	22.0	15.3	<0.01	36.1	20.1
opposition outcomes (non-pending cases)						
• patent revoked		22.9	36.1		29.7	37.6
• opposition rejected		25.0	22.6		21.4	18.8
• patent amended		38.0	33.6		38.5	36.9
• opposition closed		14.1	9.8		12.0	5.1
opposition outcomes (consolidated)						
• patent revoked or lapsed		32.7	39.9		37.1	40.2
• opposition rejected or withdrawn		29.3	28.7		26.0	21.4
• patent amended		38.0	31.6		36.9	38.5
appeal rate	<0.01	51.9	26.5	<0.01	44.3	37.7

Source: Authors' computations from ESPACE and EPOLINE data. Data on the number of claims was supplied by the EPO from its internal EPASYS database.

\* Mean value, standard errors in parentheses. Test results are obtained from simple t-tests or binomial tests (in the case of share variables).



**Table 7**  
Welfare Calculations

Parameter	Scenarios							
	1	2	3	4	5	6	3'	4'
<b>Current System Parameters</b>								
$S_L$	\$4	\$4	\$4	\$4	\$2	\$2	\$2	\$2
$S_{NL}$	\$4	\$4	\$1	\$1	\$1	\$1	\$1	\$1
$P_L$	0.032	0.011	0.032	0.011	0.032	0.011	0.032	0.011
<b>GH Estimates (Table 4, weighted averages)</b>								
$P_{O,L}$	0.198	0.198	0.198	0.198	0.198	0.198	0.198	0.198
$P_{O,NL}$	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
$P_{R,L}$	0.354	0.354	0.354	0.354	0.354	0.354	0.354	0.354
$P_{R,NL}$	0.330	0.330	0.330	0.330	0.330	0.330	0.330	0.330
$P_{PR,L}$	0.313	0.313	0.313	0.313	0.313	0.313	0.313	0.313
$P_{PR,NL}$	0.381	0.381	0.381	0.381	0.381	0.381	0.381	0.381
$P_{AL}$	0.520	0.520	0.520	0.520	0.520	0.520	0.520	0.520
$P_{A,NL}$	0.325	0.325	0.325	0.325	0.325	0.325	0.325	0.325
<b>Opposition Cost Estimates</b>								
$C_O$	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.20
$C_A$	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.20
<b>Welfare and Total Cost Estimates</b>								
$W_1$	2,588	889	2,588	889	1,294	445	1,294	445
$W_2$	23,378	23,886	5,845	5,971	5,845	5,971	5,845	5,971
$C_L$	96	33	96	33	96	33	193	66
$C_{NL}$	744	760	744	760	744	760	1,488	1,520
$W_{NET}$	25,126	23,982	7,592	6,068	6,298	5,623	5,458	4,830
$BC_{total}$	30.9	31.2	10.0	8.7	8.5	8.1	4.2	4.0

Note: all cost and benefit figures in million US\$.