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The Private Costs of Patent Litigation

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By James Bessen and Michael J. Meurer*

Abstract: This paper estimates the total cost of patent litigation to alleged infringers. We use a large sample of stock market event studies around the date of lawsuit filings for US public firms from 1984-99. We find that the total costs of litigation are much greater than legal fees and costs are large even for lawsuits that settle. Lawsuits cost alleged infringers about $28.7 million ($92) in the mean and $2.9 million in the median. Moreover, infringement risk rose sharply during the late 1990s to over 14% of R&D spending. Small firms have lower risk relative to R&D.

Keywords: patent, litigation, litigation cost, property rights

JEL Classifications: O31, O34, K41

*Research on Innovation and Boston University School of Law, and Boston University School of Law, respectively. Thanks to comments from participants at the IIOC and NBER seminars. Thanks also to research assistance from Debbie Koker and Dan Wolf.

Contact: jbessen@bu.edu

1 Introduction

Like any regulatory mechanism, the patent system has benefits and costs, both private and social. Yet little empirical evidence exists about the magnitude of some of these costs, leaving policy analysts to sometimes rely on guesstimates. For example, recent policy consideration of a patent opposition proceeding in the US (Levin and Levin 2002, Hall et al. 2004) has been based on rough estimates of the costs of patent litigation and the social costs of inappropriately-granted patents.

In contrast, there is a significant literature estimating benefits of the patent system, especially private benefits in the form of estimates of patent value[1] or of the patent premium (Arora et al. 2005). However, without comparable estimates of private and social costs, it is difficult to conduct either analysis of specific policy changes or a normative analysis of the patent system in comparison to other means of encouraging innovation. For example, Schankerman (1998) suggests that the ratio of aggregate patent value to R&D constitutes an upper bound measure of the subsidy that patents provide to R&D. He asserts that this ratio can be used to compare patents to other forms of appropriating returns on invention. But surely this is only an estimate of a *gross* subsidy against which private costs of patents need to be netted out.

This paper takes a step toward quantifying costs by estimating the private costs of patent litigation to alleged infringers. To the extent that costly patent litigation is mainly the result of inadvertent infringement—and we argue elsewhere that it is (Bessen and Meurer 2005, 2006, 2008)—then the costs of defending against inadvertent infringement represent a disincentive to investing in innovation. The risk of unavoidable infringement acts like a "tax" on innovation. Litigation can also be costly to plaintiffs, however, the expected costs of patent enforcement are presumably incorporated into patentee's valuation of patents and these have been estimated.

Litigation costs are not, of course, the only private cost of patents. There are costs of obtaining and maintaining patents; inadvertent infringement also leads to costly disputes that may be settled without lawsuits. However, during the 1990s we found evidence of a dramatic increase in the hazard of patent litigation for publicly traded firms (Bessen and Meurer 2005), so this seemed to be a potentially important cost that is also measurable.

Often, when policy analysts discuss litigation costs, they only consider the out-of-pocket legal costs of litigation. Moreover, since most lawsuits settle without going to trial, it might seem that the average legal costs of litigation are not substantial.

[1] This literature began with Pakes and Schankerman (1984). See Bessen (2006a) for a survey of this literature.

But legal costs are not the only costs of litigation that affect innovating firms. Business costs of litigation can be much larger and can take many forms. Business can be disrupted as managers and researchers spend their time producing documents, testifying in depositions, strategizing with lawyers, and appearing in court. Litigation strains the relationship between the two parties and may jeopardize cooperative development of the patented technology or cooperation on some other front. Firms in a weak financial position might see their credit costs soar because of possible bankruptcy risk created by patent litigation. Preliminary injunctions can shut down production and sales while the litigation pends. But even without a preliminary injunction, customers may stop buying a product. Frequently, products require customers to make complementary investments; they may not be willing to make these investments if a lawsuit poses some risk that the product will be withdrawn from the market. Furthermore, patent owners can threaten customers and suppliers with patent lawsuits because patent infringement extends to every party who makes, uses, or sells a patented technology without permission, and sometimes to those who participate indirectly in the infringement. Some of these costs can be quite substantial even when the lawsuit is settled. In addition, in cases of inadvertent infringement, the payments necessary to achieve a settlement from unavoidable disputes can constitute a substantial risk.

Even simple delay can impose large business costs. Consider, for example, litigation against Cyrix, a startup firm that introduced Intel-compatible microprocessors. Intel, the dominant microprocessor maker, sued Cyrix and the suit lasted a year and a half. During that time Cyrix had difficulty selling microprocessors to computer manufacturers, who were almost all also customers of Intel and who were reluctant to break ranks to go with a product that might be found to infringe. In the meantime, Intel responded by accelerating its development of chips that would compete against Cyrix's offerings. In the end, Cyrix won the lawsuit, but lost the war, having lost much of its competitive advantage. In effect, Cyrix lost the window of opportunity to establish itself in the marketplace. Litigation exacted a heavy toll indeed.

Although we gather some original information about legal costs of litigation, our main emphasis is on estimating the total business cost to alleged infringers in order to estimate firm risk of infringement. We do this using a large number of event studies on lawsuits involving publicly traded firms from 1984 through 1999.

The event study methodology has been used before to study litigation, beginning with Cutler and Summers (1988) in the context of litigation over a merger. Several papers have

performed event studies of patent litigation, both the event of the initial filing and the terminating event (settlement, judgment or verdict), including Bhagat, et al. (1994), Lerner (1995), Bhagat et al. (1998), Lunney (2004) and Haslem (2005). Our contribution is to work with a much larger set of disputes, covering all public firms over a longer time frame. This gives our results greater precision, permitting us to calculate a variety of cost and risk measures.

A key assumption of this literature is that the change in firm value that occurs around a lawsuit filing reflects investors' estimates of the direct and indirect effects of the lawsuit on the profits of the firm and not any unrelated information. We argue below that this is a plausible assumption for defendants in infringement suits and that, therefore, we may associate the loss in wealth with the effective total cost of litigation for defendants.

We find that firms lose about half a percentage point of their stock market value upon being sued for patent infringement. This corresponds to a mean cost of $28.7 million in 1992 dollars (median of $2.9 million), much larger than mean legal fees of about half a million. In aggregate, infringement risk rose sharply during the late 1990s, reaching 19% of R&D spending.

The next section describes the data and methods used for estimating cumulative abnormal returns. Section 3 reports average returns and some analysis of factors that affect returns. Section 4 calculates litigation cost, Section 5 calculates some broader measures of infringement risk and Section 6 concludes.

2 Data and Methods

2.1 Data Sources

Our research matches records from three data sources: lawsuit filings from Derwent's Litalert database, firm financial data from Compustat, and CRSP data on securities prices. In addition, we searched the electronic archives of the Wall Street Journal to locate any articles announcing lawsuit filings and also any announcements of other events that might confound our analysis.

Using these sources, we constructed two main samples. The first, small sample included just those lawsuits where we could identify one or more parties on both sides of the dispute as public firms. The second, large sample included all cases where the alleged infringer (defendant in an infringement suit or plaintiff in a declaratory action) was a publicly traded firm, but the patentee litigant need not be public.

Our primary source of information on lawsuit filings is Derwent's Litalert database, a database that has been used by several previous researchers (Lanjouw and Schankerman, 2004, Ziedonis, 2004, Bessen and Meurer 2005). Federal courts are required to report all lawsuits filed that involve patents to the U.S. Patent and Trademark Office (USPTO) and Derwent's data is based on these filings. Beginning with the Derwent data from 1984 through 2000, we removed duplicate records involving the same lawsuit as identified by Derwent's cross-reference fields. We also removed lawsuits filed on the same day, with the same docket number and involving the same primary patent. Sometimes firms respond to lawsuits by filing counter-suits of their own, perhaps involving other patents. Since our main focus is on initial disputes rather than on lawsuit filings *per se,* we also removed filings made within 90 days of a given suit that involved the same parties.

The Derwent data does not distinguish whether the suit filed is an infringement suit or a declaratory judgment suit. A firm threatened with an infringement suit can file a declaratory action which aims for a judgment that the patent is uninfringed or invalid. To classify each suit, we first identified whether the patent assignee of the main patent at issue matched one of the parties to the suit. If the assignee matched a plaintiff, the suit was classified as an infringement suit; if the assignee matched a defendant, the suit was classified as a declaratory action. We were able to match the assignee for 83% of the suits, and of these, only 17% were declaratory actions.[2] If the assignee did not match a party to the suit, then it was classified as an infringement suit because there are relatively few declaratory actions. This classification then allowed us to identify whether the subject firm was a "patentee litigant" (that is, plaintiff in an infringement suit or defendant in a declaratory action) or an "alleged infringer" (the reverse).

To explore characteristics of firms involved in these lawsuits, we matched the listed plaintiffs and defendants to the Compustat database of U.S. firms from 1984-99 that report financials (excluding American Depository Receipts of foreign firms traded on US exchanges). These data were based on merged historical data tapes from Compustat and involved an extensive process of tracking firms through various types of re-organization and eliminating duplicate records for firms (e.g., consolidated subsidiaries listed separately from their parent companies).[3]

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[2] These numbers are quite similar to findings by Moore (2000) and Lanjouw and Schankerman (2004).

[3] This work was conducted by Bob Hunt and Annette Fratantaro at the Federal Reserve Bank of Philadelphia for an earlier project and we thank them for graciously sharing it with us.

The lawsuit data were matched to the Compustat data by comparing the litigant names with all domestic firm names in Compustat and also a list of subsidiary names used in Bessen and Hunt (2007).[4] To check the validity and coverage of this match, we randomly selected a number of parties to suits and then checked them manually using various databases including PACER, LexisNexis, the Directory of Corporate Affiliations and the LexisNexis M&A databases. Although we were not able to definitively identify all parties, the rate of false positives was not more than 3% (no more than 5 of 165 parties were found to have been falsely matched) and the rate of false negatives was no more than 7% (no more than 34 of 502 public companies were not matched). The Compustat firms were then also matched to the CRSP file of daily security prices.

We identified 2,648 suits with sufficient data on alleged infringers, some of these having multiple alleged infringers, for a total of 2,887 events in our large sample. We also selected all those lawsuits where we could identify at least one party on each side as a publicly listed firm. This left us with 891 lawsuits for our small sample. However, not all of the matched firms had sufficient stock price data to conduct an event study, so the usable sample size was slightly smaller (750 plaintiffs and 747 defendants).

Finally, each lawsuit in the small sample was checked against the Wall Street Journal archive to identify those suits that were announced in the Journal within one month of the filing data and to identify possible confounding news about either party to the suit within one week of the filing date.

In Section 4 we discuss a supplemental dataset of lawsuits that reports legal fees.

2.2 Estimating Cumulative Abnormal Returns

To estimate the impact of a lawsuit filing on the value of a firm, we use event study methodology (see Mackinlay 1997 for a review). In particular, we use the dummy variable method described by Michael Salinger (1992). This assumes that stock returns follow a market model,

$$r_t = \alpha + \beta r_t^m + \epsilon_t \quad (1)$$

[4] A software program identified and scored likely name matches, taking into account spelling errors, abbreviations, and common alternatives for legal forms of organization. These were then manually reviewed and accepted or rejected. Note that this match is based on the actual parties to litigation, not the original assignee of the patent at issue.

where r_t is the return on a particular stock at time t, r_t^m is the compounded return on a market portfolio, and ϵ_t is a stochastic error. If an event, such as a lawsuit filing, occurs on day T, then there may be an "abnormal return" to the particular stock on that day. This can be captured using a dummy variable,

$$(2) \qquad r_t = \alpha + \beta r_t^m + \delta_t + \epsilon_t$$

where δ_t equals 1 if $t=T$ and 0 otherwise. Equation (2) can be estimated using OLS for a single event. In practice, this equation is estimated over the event period and also over a sufficiently long pre-event window. In this paper we use a 200 trading-day pre-event window.[5] The coefficient estimate of δ_t obtained by this procedure is then an estimate of the abnormal return on this particular stock.

We want to obtain a representative estimate of the abnormal returns from lawsuit filings for multiple stocks, under the assumption that these represent independent events and that they share the same underlying "true" mean. A common practice is to simply take an unweighted mean of the estimates of δ. Salinger notes that equation (2) also generates an estimate of the variance of each estimate as well. For different stocks, the estimates of δ will vary depending on how well equation (2) fits the data. So a better procedure is to use a weighted mean to estimate the "average abnormal return," where the weight for each observation is inversely proportional to the corresponding variance estimate.

Also, as Salinger (1992) notes, this procedure assumes that the returns for each event are independent of each other. However, when there are multiple defendants in a suit, returns may be systematically related. For example, one defendant may be a supplier to another or two defendants may be unequal rivals. Since the large sample has 188 lawsuits with multiple defendants, in these cases we estimate the returns for the defendants to each suit jointly, estimating common abnormal returns for this group of defendants.

Finally, (2) describes the abnormal return for a single day. It is straightforward to design dummy variables to estimate a "cumulative abnormal return" (CAR) over an event window consisting of multiple consecutive days. In the following, for instance, if the suit is filed on date $t=T$, then we may use a window from day T-1 to T+24.

[5]We also ran regressions with a 180 day pre-event window that ended 30 days before the lawsuit filing. Cumulative abnormal returns were very close to those with a 200 day window that last up to the day before the event window.

3 Empirical Findings

3.1 Estimates of cumulative abnormal returns

Since previous studies have used samples where parties on both sides of a lawsuit were public firms and the suits were reported in the Wall Street Journal, we begin by exploring a sub-sample. Table 1 shows estimates of cumulative abnormal returns for just those suits from our small, matched sample that were reported in the Wall Street Journal. In this table, we exclude suits that had a potentially confounding news story in the Wall Street Journal within a month of the suit filing date. Two previous studies have reported on event study estimates on announcements of patent lawsuits filings in the Wall Street Journal. Bhagat et al. (1998) examine lawsuits filed between 1981 and 1983 (51 plaintiffs and 33 defendants) and Lerner (1995) obtains estimates for 26 biotech lawsuits from 1980 to 1992.[6] To maintain consistency with the previous literature, in this Table (but not in the next) we report simple unweighted means of cumulative abnormal returns.[7] The mean and median values are reported for two different event windows, one around the Wall Street Journal publication date, the other a longer window around the actual suit filing date reported in court records (these dates occasionally differed significantly).

Consistent with most of the previous literature on litigation, we find that patentee litigants do not show a positive response to a lawsuit filing. Bhagat et al. (1998) report a CAR of -0.31%, and we find a similar value. For defendants (alleged infringers), we find a substantial loss in market value of around 2%. Bhagat et al. report a loss of 1.50%. For the combined loss of wealth, we find a mean of 2.5-2.6%, although smaller median values. Bhagat et al. (1994) report a mean loss of 3.13% and Lerner (1995) reports a mean loss of 2.0%. All three results are broadly similar and quite substantial. Lerner reports a mean absolute loss of shareholder wealth of $67.9 million, a median loss of $20.0 million. In general, there does not appear to be a major difference between the results reported in the event window around the Wall Street Journal publication date and the longer window around the filing date.

Estimates for this sample may be unrepresentative of most patent litigation, however, because most lawsuits are not reported in the Wall Street Journal. Reported suits may exhibit a selection effect: perhaps suits that have more at stake tend to be reported more often. In this case, the typical loss of market value would be larger for those cases that are reported. But also,

[6] Bhagat et al. (1998) includes the data from the Bhagat et al. 1994 paper, so we do not list that separately.

[7] For this reason, this table does not report standard errors or significance tests.

publication in the Journal may do a lot to make investors aware of the suit, hence the reaction may be larger. In this case, estimates of cumulative abnormal returns for other cases might not reflect the true loss of value to the firm simply because many investors remained unaware of the lawsuit in the unreported cases .

Table 2 reports cumulative abnormal returns for all lawsuits in the matched sample (top) as well as those for the large sample (bottom). The base result for the matched sample uses a 25 day event window (T-1 to T+24) and excludes possibly confounding events. The table also reports CARs for a 4 day window (T-1 to T+3), for suits that were positively identified as infringement suits (that is, the plaintiff was the patent assignee), and for a sample that included lawsuits with possibly confounding news events. The reported means and standard errors use weights based on the variance of the dummy variable coefficient in the event regression. Several results stand out.

First, it is clear that the estimates for the longer window are both economically and statistically more significant, despite the larger associated standard errors. This suggests that investors do, indeed, learn about the lawsuit over time in the several weeks following the filing.

Second, the estimated percentage losses for alleged infringers are substantially less than those for lawsuits reported in the Wall Street Journal in Table 1. We cannot tell, however, whether the percentage loss estimates in the Journal are larger because of a selection effect or because of the greater information conveyed by publication in the Journal. Even though some learning takes place, we suspect that in most lawsuits, investors remain relatively uninformed compared to those cases where an announcement is published in the Wall Street Journal. The SEC requires reporting of major lawsuits in quarterly and annual filings, but lawsuits will be reported separately only if they materially affect the profits of the firm. For a handful of suits, we checked published sources and typically found no mention of the suit. For this reason, estimates for the non-Journal sample should be interpreted as lower bound estimates of defendant firms' loss of wealth—significant numbers of investors likely became informed about the suit either after our event window or, if there were pre-filing interactions, before.

Third, for the longer window, patentee litigants/plaintiffs appear to suffer some losses as well. These losses are smaller than those for alleged infringers/defendants, but they are statistically significant. This is consistent with previous research and it indicates that lawsuits do not represent simple transfers of wealth on average. Instead, there is dissipation of wealth to consumers, to rivals or to deadweight loss.

Finally, the magnitudes of returns for definite infringement suits are generally larger than for those of all suits and they show a higher level of statistical significance. This may be because among those cases where we could not match the patent to one of the parties, some plaintiffs are mistakenly classified as defendants and vice versa. Or it could be because declaratory actions may be more likely when the stakes at issue are smaller. We explore this below.

The bottom of Table 1 reports results for our large sample. The CARs for alleged infringers are similar to those obtained from the smaller sample—a loss of 0.5% to 0.6%—but here they have statistical significance at the 1% level, except for those lawsuits involving multiple defendants.

When multiple defendants are involved the returns are negligible, suggesting that something is fundamentally different about these estimates. There are several possible explanations for this. It may be that suits naming multiple defendants are more frivolous, so that investors do not expect serious losses. Alternatively, some defendants may have been contractually indemnified, diluting the estimates. A higher percentage of defendants in lawsuits with multiple defendants come from retail and wholesale industries, suggesting that these suits more frequently involve downstream resellers who have less at stake. Costs may be shared among multiple defendants, reducing the individual firm costs. Also, antitrust authorities may be more likely to scrutinize settlements when multiple defendants are involved.

The estimates in the lower portion of the table do not control for possibly confounding events. However, we find that excluding observations with possibly confounding events does not seem to substantially alter the mean estimated CARs in the top portion of the table (the matched parties sample). To check this further, we repeated the estimates for the large sample of all alleged infringers, but we terminated the pre-event window 30 days prior to the filing of the lawsuit. This made little difference in our estimates, suggesting that confounding events may add noise, but do not bias our estimates.[8]

Figure 1 shows histograms for the cumulative abnormal returns for all lawsuits from the matched sample. The curve for alleged infringers/defendants clearly falls to the left of the curve for patentee litigants/plaintiffs, but both curves are quite diffuse. The distributions are significantly leptokurtic (kurtosis of 7.2 and 9.7 for plaintiffs and defendants, respectively), meaning that they have long tails. This suggests that outliers may be influential. To make sure that our results are not driven by outliers, we also conducted non-parametric tests (the binomial probability test and the Wilcoxon signed rank test) on the large sample and several sub-samples.

[8]For example, the estimate for single defendants was 0.608% (0.176%) for the full 200 day pre-event window and 0.609% (0.178%) for the truncated window.

All of these tests rejected the null hypothesis of a CAR of zero at either the 5% or the 1% level of statistical significance. In addition, the close correspondence between the means and the medians suggests that our mean estimates for alleged infringers are representative.

3.2 Factors affecting suit nature and announcement

Some of the difference observed in the first two tables may be endogenous. Firms may decide whether or not to issue a press release, which is likely to cause an article in to be published in the Wall Street Journal. Patentee litigants can be more or less aggressive in filing a lawsuit, affecting the likelihood of whether the suit ends up as an infringement suit or as a declaratory action.

Table 3 explores possible explanatory factors using Probit regressions. The first three columns explore factors affecting whether the suit appears in the Wall Street Journal or not. We consider characteristics of both the patentee litigant and the alleged infringer. The characteristics include firm size (log employment), whether the firm is newly listed (first appeared in Compustat within 5 years), research intensity (R&D to sales ratio greater than .5), real capital per employee, and total book liabilities to total book assets. All regressions also include industry dummies. The patentee litigant's capital intensity seems to be a significant factor promoting announcement. On the other hand, the patentee's ratio of liabilities to assets, which may be taken as a measure of financial distress, appears to be associated with a desire not to announce the lawsuit. As we shall see in the next section, this ratio is also associated with a larger negative return for plaintiffs, so managers might have good reason to keep the news of a suit out of the Wall Street Journal.

The last two columns explore characteristics that may affect whether the suit is an infringement suit or a declaratory action. It appears that newly public patentees may be a bit more aggressive in filing suits, while larger alleged infringers may be more likely to end up in an infringement suit. Large firms may avoid filing declaratory actions, waiting for evidence that the patent owner has the resources to conduct a lawsuit.

3.3 Factors affecting Abnormal Returns

Table 4 explores factors that might influence the magnitude of investors' reactions to lawsuit filings by comparing means of different sub-groups. We test differences in the means of different sub-groups using one-tailed *t*-tests, allowing unequal variances between the sub-groups and calculating the degrees of freedom using Satterthwaite's approximation (1946). We conduct

these comparisons both for the subject firm's characteristics as well as characteristics of its opposing party in the lawsuit. We also ran regressions with various combinations of the variables in Table 4 (or continuous equivalents) on the right hand side. However, given the noisiness of our data, little conclusive could be drawn from these regressions and where significant results were found, they matched the results found with simple *t*-test comparisons of means.

For patentee litigants, we find that firms with high liabilities relative to assets (and to a lesser extent, firms with high current liabilities to current assets) have much more negative returns from initiating lawsuits. One explanation is provided by Haslem (2005), who observes that lawsuit settlements, including patent settlements, are associated with a decline in firm value, on average. Following Jensen and Meckling (1976), he argues that poorly governed firms will tend to settle lawsuits too soon (from the perspective of shareholders) because that allows managers to expend less effort. Firms with low debt have more leeway for managerial discretion. He finds that these firms experience greater declines in value on settlement. By similar logic, firms with low debt may have more discretion about which lawsuits to file. Therefore, they may choose to file just the most profitable lawsuits while managers in more debt-laden companies may be driven to file more marginal lawsuits, leading to relatively lower CARs.

Another explanation might arise if some industries have a "mutual forbearance" repeated game type equilibrium—firms mutually avoid suing each other because they recognize that if they initiate a suit, they may be punished in the future with retaliatory suits. However, a failing firm may have limited future prospects, hence little to fear from future retaliation. So failing firms, which have high liabilities, may be more likely to initiate suits, including less profitable suits.

For alleged infringers, we find four statistically significant differences . First, if the parties to the lawsuit are in different industries, then the alleged infringer suffers a substantially larger loss, which is statistically significant at the 1% level. Suits from outside the industry may be more of a surprise to investors and may be more indicative of inadvertent infringement. Alternatively, when disputes occur within a narrow industry, the parties may have greater latitude to craft a settlement that benefits both jointly, including, perhaps, collusive settlements.

The remaining three differences are statistically significant at the 5% level. First, small firms seem to have substantially more negative returns. This result appears robust to alternative cutoff points below 500 employees, but we found no significant variation in returns among firms larger than that. One explanation for this is that legal costs are relatively higher for small firms,

creating a "floor" on the costs of litigation. Second, we find limited evidence that R&D intense firms suffer more negative returns, however, this result seems sensitive to the specific cutoff used. Finally, we also find some evidence that returns were worse during the 1990s compared to the 1980s. Note that the lower returns for alleged infringers do not appear to be matched by greater returns to patentee litigants (top of the table). In other words, this evidence of greater losses does not suggest a greater transfer of wealth to patent holders.

4 The Costs of Patent Litigation

4.1 Legal Costs

We first look at the legal costs of patent litigation using supplemental data we collected from legal records. We then estimate the total business costs of litigation to alleged infringers based on our event study estimates.

Certain U.S. patent lawsuits contain data on direct legal costs. American patent law provides that the winning party's attorneys' fees can be shifted to the losing party at the discretion of the judge in exceptional cases. Patentees usually get fee awards based on a finding of willful infringement, and alleged infringers usually get fee awards based on a finding the patent suit was frivolous or vexatious. When parties are awarded fees they are required to document their fees, and this information is often included in publicly available records. We searched Westlaw for all patent cases from 1985-2004 that discussed fee-shifting. We found 352 cases in which one of the parties requested fees (about 100 patent cases go to trial per year). The request was granted in 137 (or 38.9%) of these cases. From this set of 137 cases we were able to determine the magnitude of the fees in 87 cases (63.5% of awards) from judicial opinions or from documents filed by the parties available through the PACER system.

Table 5 shows the median and mean amounts of the fee awards in millions of year 1992 dollars. Mean fees for cases that went through trial ranged were $1.04 million for patentee litigants and $2.46 million for alleged infringers. For cases that were decided prior to trial, the mean fees were $0.95 million for patentee litigants and $0.57 million for alleged infringers.[9] Median values tend to be smaller because the distribution is skewed. In the most extreme case, a $26 million fee was awarded to Bristol-Myers Squibb in conjunction with a successful defense against a pharmaceutical patent suit brought by Rhone-Poulenc. The next largest award was about $7 million.

[9] We included cases that ended in summary judgments, one case that settled, one case that was a default judgment, and one case that ended in a motion to dismiss.

Our fee-shifting data is in line with survey information collected by the American Intellectual Property Law Association (AIPLA). AIPLA asked patent litigators to estimate the fees associated with patent lawsuits under six different scenarios. Specifically, the survey question divided cases into three different intervals based on stakes, and asked for estimates for cases that concluded at the end of discovery, and cases that reached trial. Their 2001 report indicates the estimated cost through trial was $499,000 when the stakes are less than $1 million, $1.499 million when the stakes are between $1 million and $25 million, and $2.992 million when the stakes are over $25 million.[10] The estimated cost through discovery was $250,000 when the stakes are less than $1 million, $797,000 when the stakes are between $1 million and $25 million, and $1.508 million when the stakes are over $25 million.[11]

The expected legal cost associated with the filing of a patent lawsuit depends on the frequency of the different ways a lawsuit may be terminated. Kesan and Ball (2005) analyze patent lawsuit termination data available from the Administrative Office of the federal judiciary. Examining 5,207 lawsuits that were filed in 1995, 1997, and 2000, they find that most cases terminate short of trial, summary judgment, or other substantive court rulings. In particular, 4.6% of lawsuits reached trial, 8.5% of lawsuits terminated with a summary judgment, dismissal with prejudice, or confirmation of an arbitration decision, and the remaining 86.9% of cases terminated earlier in the process.

Kesan and Ball construct two proxies for legal fees in patent lawsuits: number of days until the suit terminates, and number of documents filed. Their data show that suits that go to trial last about 1.5 times as many days as suits that end with a summary judgment, and suits that end with a summary judgment last about 1.5 times as many days as all other suits. Further, their data shows that suits that go to trial generate about 2.5 times as many documents as suits that end with a summary judgment, and suits that end with a summary judgment generate about 2.5 times as many documents as all other suits.[12] If we assume that the expected legal cost in a suit that ends before summary judgment is one-half of the cost of suit that reaches summary judgment, then using our data in Table 5 we have estimates of $410,000 for the alleged infringer, and $624,00 for the patentee. A similar calculation using AIPLA data for stakes between $1 million and $25 million yields an estimate of $483,000.

[10] These amounts increased substantially in the 2003 and 2005 AIPLA reports.

[11] The AIPLA estimate of costs through discovery should be larger than the fees shifted at the summary judgment stage to the extent that discovery continues after summary judgment.

[12] We derive these ratios from their Tables 10-12.

4.2 Total Costs

Using our CAR estimates, we can estimate the loss of wealth that occurs upon a lawsuit filing. From this, we can then infer a cost to alleged infringers. Multiplying the mean CAR by the value of the outstanding shares of common stock immediately prior to the lawsuit filing, we obtain a mean loss of wealth in 1992 dollars of $52.4 million and a median loss of $4.5 million.[13] These estimates are somewhat smaller than Lerner's estimate for biotech companies of a mean loss of $67.9 million and a median loss of $20.0 million.

This loss of wealth corresponds to the associated drop in investors' expected profits. Investors expect lower profits because of the direct and indirect costs that the litigation imposes on the firm. They might also expect lower profits if the filing of the lawsuit somehow revealed previously unknown information about the prospects for the firm. However, we can think of no reason why patent lawsuits would consistently signal negative information for alleged infringers, other than the information specifically associated with the consequences of the lawsuit. Indeed, if anything, when a firm is sued, investors may view this as a sign that its technology has been successful. So we expect our estimates to reflect the loss of wealth associated with the costs of the lawsuit or, perhaps, to understate that loss.

However, if we want to know how much litigation "taxes" investment in innovation, then we need to calculate something other than the loss of wealth. That is, we define the "cost of litigation" as the the amount that the firm has to invest in order to increase its value to the level it had just prior to the lawsuit, all else equal. This does not necessarily equal the amount of wealth the firm loses because firms are not necessarily operating at the long-run steady state. They may, instead, be undergoing dynamic adjustment. Then changes in investment will be larger or smaller than the associated changes in firm value. In particular, assuming constant returns to scale, an additional investment of one dollar should increase firm value by an amount equal to Tobin's Q.

Following this logic, to calculate the cost of litigation, we divide the estimated loss of wealth by Tobin's Q.[14] This gives us a mean cost of litigation to alleged infringers of $28.7 million and a median cost of $2.9 million in 1992 dollars.

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[13] Specifically, to be conservative, we do this by categories: we multiply the common stock capitalization by .00012 for firms in cases with multiple defendants, by .00564 for single defendants with more than 500 employees, and by .0208 for small single defendants. The mean CAR for each event study, an alternative measure, has a mean of $83.7 million. The estimate we used should be asymptotically equivalent but more efficient, assuming our size categorization is correct.

[14] We calculate Tobin's Q as the aggregate value of firms divided by the inflation-adjusted value of the aggregate sum of accounting assets and R&D. For details on the computation of these quantities, see Bessen (2006b).

These estimates are clearly much larger than the estimates of direct legal costs. Most of the cost of litigation to firms appears to arise from business costs such as loss of market share, management distraction, and increased financial costs from greater risk. These costs are incurred even if the suit does not proceed to trial, as happens most often.

It is interesting to compare our estimate to data from cases that proceed to trial. For the small number of reported cases that go to trial, are won by the patentee, and which award damages to the patentee, we can compare the magnitude of these damages. Mean reported lawsuit damages from 1991-2005 are $10.7 million in 1992 dollars.[15] This number does not include the business cost of the injunction to the infringer, which is often much larger than the damages. For example, the court found damages of $53.7 million in NTP v. RIM, but because of the injunction, NTP eventually settled for $612 million. This mean also does not include the costs of pursuing the litigation, both direct payment of legal costs and indirect business costs. Nevertheless, it is reassuring that this figure is of the same order of magnitude as our mean estimate.

5 The Risk of Infringement for Public Firms

These cost estimates can be summed over all the observed lawsuit filings to obtain measures of firm risk. Table 6 shows three related measures.

The first column lists the annual cost of litigation obtained by summing the cost over all the events in our large sample in each year of the sample. During 1996-99, this averaged $14.9 billion in 1992 dollars. However, this figure has varied considerably over time, increasing dramatically from $2.0 billion in 1984 to $16.1 billion in 1999. Figure 2 shows the annual time series. The rise began in the early 1990s and closely follows the increasing frequency of litigation (Bessen and Meurer 2005). But other factors contributed as well, including the increase in R&D spending. Below we look at infringement risk normalized by R&D. The absolute cost of litigation was borne almost entirely by large firms and nearly half by firms in the computer, electronics and software industries.

Note that this series may be substantially understated because, as is well-known, the Derwent Litalert data under-report lawsuits (Lanjouw and Schankerman 2004, Bessen and Meurer 2005). In our 2005 working paper using this sample, we find that only about 64% of lawsuits are reported in Derwent. We have left the first column uncorrected, since it reports a

[15] This figure is the mean of deflated annual means reported in Pricewaterhouse Coopers (2006).

simple sum for our sample. However, the second and third columns compare litigation cost to numbers of firms and to R&D spending, respectively, so to make the appropriate comparisons, we correct these for under-reporting by dividing by 0.64.[16]

On the other hand, this series may slightly overstate the aggregate cost of patent litigation *per se* because some of the suits listed involved more than just charges of patent infringement and validity. For example, sometimes patent owners will combine allegations of patent infringement with allegations that other rights (including other intellectual property rights) have been violated. Some of the suits of this sort might occur even if there were no patent infringement at issue, so it might not be appropriate to include all of the costs associated with these suits in an aggregate estimate of patent litigation costs. However, for two reasons we do not think this is a serious problem. First, searching published court decisions between 1991 and 1999, only 11% of patent infringement and validity suits also involved claims involving trade secrets, trademarks, copyright, false advertising, unfair competition or noncompete clauses.[17] Second, in Table 4 we observed that the alleged infringer's losses are much greater for inter-industry suits than for intra-industry suits. Since most of the cases involving these additional legal issues occur between rivals in the same industries, these suits do not contribute much to aggregate litigation costs. So it seems unlikely that our aggregate cost estimates overstate the costs of patent litigation by more than a few percent.

The second column displays the annual firm infringement risk. This is the mean expected cost of litigation for a firm from patent infringement lawsuits (or related declaratory actions). It averaged $4.5 million during 1996-99 and it shows a similar pattern of distribution.

The third column shows the ratio of annual litigation cost to annual aggregate R&D. This averaged 14.0% during 1996-99. This relative rate also increased from 1984 to 1999, more than tripling to 19.3% (roughly in line with the growth of the litigation hazard), but this increase was not as rapid as for the quantity in column 1. Note that relative to R&D, litigation risk is low for small firms and for firms outside of the chemical, pharmaceutical and tech industries.

It is tempting to compare this ratio with the "equivalent subsidy rate" for patents, that is, the aggregate value of patents divided by the value of the corresponding R&D. Schankerman (1998) suggests that this ratio represents an upper bound on the subsidy that patents provide to

[16] Lanjouw and Schankerman (2004) found no significant differences between the characteristics of the reported and unreported lawsuits.

[17] Based on a search of case synopses in the Westlaw FIP-CS database.

invest in innovation. But, as we argued above, this is clearly a gross subsidy that can be offset by litigation risk if innovators risk inadvertent infringement and by other costs. Several papers calculate this ratio by comparing the value of a nation's patents (estimated using patent renewal data) to R&D (calculated by allocating national R&D spending to the patents obtained in the subject country). Lanjouw et al. (1998) review this literature and report that most subsidy rates are on the order of 10-15%. Arora et al. (2005), use survey data to obtain a comparable estimate of 17%.

However, these numbers are not directly comparable to our estimates of relative litigation risk for at least three reasons. First, because of the way these studies allocate global R&D, they effectively report the subsidy provided by worldwide patents, not patents in a single country.[18] However, the litigation cost is only for US litigation and does not include the costs of litigation in other countries nor the costs of other dispute resolution such as opposition proceedings. An "apples-to-apples" comparison would include these costs as well.

Second, the subsidy rate calculations based on patent value use the value of all of the nation's patents, including patents from individual inventors and small firms. The litigation risk estimates are only for public firms; these are the firms that conduct the lion's share of R&D. A more appropriate comparison would calculate subsidy rates using patents values only for public firms (see Bessen 2006a for comparable figures). In any case, public firms may experience both different subsidy rates and different litigation costs than other firms.

Finally, the litigation costs are estimated for the current year, but the value of patents granted reflects a stream of profits in *future* years. Ideally, we would want to compare litigation costs to the profits from patents on the same cohort of technologies that were litigated. Some of these profits are realized prior to the time of litigation. Since both litigation costs and patent values are trending up, this use of current patent values understates the significance of litigation costs.

All three of these considerations suggest that a direct comparison of reported subsidy rates to US litigation risk overstates the relative positive value of patents. At the very least, these estimates suggest that litigation risk is quite large compared to the private benefits of patents, especially in recent years.

[18] That is, using trade data, they allocate a share of the R&D performed in every OECD country to, say, French patents when they calculate the subsidy rate using the value of French patents. The apparent assumption behind this allocation is that subsidy rates are the same across nations and that the share of trade is proportional to each nation's share of worldwide patent value. Then the calculated subsidy rate will represent the return from worldwide patents. Similarly, Arora et al. use US patents as a right hand variable, but this proxies for each firm's worldwide patents.

6 Conclusion

Using a large set of event studies, we estimate the total cost that patent litigation imposes on firms and we estimate the risk of infringement litigation. We find that, contrary to what is sometimes assumed, the business costs of litigation far exceed the direct legal costs. And we find that by the late 1990s, patent litigation risk was of the same order as, if not larger than, estimates of the private benefits firms receive from patents. Moreover, consistent with the previous literature, the losses to alleged infringers do not correspond to a transfer of wealth to patent holders; instead there is a substantial joint loss of wealth. Our estimates concern private costs rather than the social costs of litigation, nevertheless these estimates tell us something about the effectiveness of patents as a policy tool to encourage investment in innovation.

In the best case, this suggests that the patent system is at present an inefficient form of subsidy or regulation. Thomas Hopkins estimates the total 1992 cost of general regulatory compliance is $389,911 per firm (in 1995 dollars).[19] But the costs of complying with the patent system—annual infringement risk of $4.5 million—are much larger.

In the worst case, the net effect of patents today may be to reduce the profits of public firms and to possibly impose disincentives on innovative activity as well. Exploration of the possible causes and the significance of this for policy and for normative analysis are beyond the scope of this paper, however.

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Tables and Figures

Table 1. Cumulative Abnormal Returns from Suits Announced in Wall Street Journal, 1984-99

Event window	WSJ article T-2 to T+1	Suit filing T-1 to T+24	Bhagat et al. (1998)
Patentee Litigant (Plaintiff)			
mean	-0.3%	-0.1%	-0.31%
median	0.0%	0.9%	
no. of observations	86	86	
Alleged Infringer (Defendant)			
mean	-2.6%	-1.8%	-1.50%
median	-1.4%	-1.9%	
no. of observations	82	82	
Combined (matched parties)			
mean	-2.6%	-2.5%	
median	-1.8%	-0.5%	
no. of observations	80	80	
Addendum: mean combined abnormal returns			
Bhagat et al. (1994)	-3.13%		
Lerner (1995)	-2.0%		

Note: Events with possibly confounding news are excluded. Average cumulative abnormal returns are simple unweighted means.

Table 2. Cumulative Abnormal Returns

	Mean CAR	Median CAR	Observations
Sample: Matched Parties			
Patentee Litigants			
Base	-0.38% (0.30%)	0.00%	667
4-day window	0.08% (0.12%)	-0.18%	680
Definite infringement suits	-0.63% (0.37%)*	-0.45%	412
With possibly confounding events	-0.63% (0.28%)*	-0.16%	750
Alleged Infringers			
Base	-0.62% (0.33%)*	-0.97%	661
4-day window	-0.20% (0.14%)	-0.49%	674
Definite infringement suits	-0.77% (0.42%)*	-0.83%	407
With possibly confounding events	-0.45% (0.31%)	-0.57%	743
Sample: All alleged infringers			
Base	-0.50% (0.16%)**	-0.51%	2,887
Single defendants	-0.61% (0.18%)**	-0.54%	2,460
Multiple defendants	-0.01% (0.39%)	-0.39%	427
Single defendants, definite infringement cases	-0.63% (0.27%)**	-0.42%	1,108

Note: Standard errors in parentheses. Single asterisk indicates statistical significance at the 5% level; double asterisk indicates 1% significance. Average cumulative abnormal returns are weighted means, with weights proportional to the inverse of the estimated variance of each return. In matched sample, events with possibly confounding news are excluded, except where noted. Event window is 25 days (T-1 to T+24) except where noted. Cumulative abnormal returns are estimated using OLS except for cases with multiple defendants (in large sample), which are estimated jointly.

Table 3. Suit Announcement and Type

	Wall Street Journal Article			Infringement Suit	
	1	2	3	4	5
Plaintiff/patentee litigant					
Ln employment	-0.02 (0.03)			0.02 (0.03)	0.04 (0.04)
New firm	-0.22 (0.20)			**0.63** (0.29)	
R&D/sales > .5	0.33 (0.18)	0.35 (0.18)			
Capital / employee		**0.86** (0.38)	**1.25** (0.50)		-0.68 (0.52)
Total liabilities / assets (book)			**-0.77** (0.35)		-0.21 (0.43)
Defendant/alleged infringer					
Ln employment	-0.01 (0.03)			0.06 (0.03)	**0.08** (0.04)
New firm	0.20 (0.18)			-0.01 (0.20)	
R&D/sales > .5	0.14 (0.18)	0.18 (0.17)			
Capital / employee		0.14 (0.36)	0.41 (0.42)		-0.93 (0.57)
Total liabilities / assets (book)			-0.70 (0.37)		-0.35 (0.42)
No. of observations	681	680	544	507	413
Pseudo-R-squared	0.025	0.031	0.055	0.023	0.047

Note: Probit regressions. Robust standard errors in parentheses. Bold estimates are significant a the 5% level or better. Regressions include industry dummies (not shown).

Table 4. Differences in Mean CARs by Characteristics

	Alleged Infringer	Patentee Litigant
Sample: Matched Parties		
Firm characteristic		
Employees < 500	-3.20% (2.32%)	-3.75% (2.42%)
R&D / Sales > .15	-0.22% (2.16%)	-0.53% (1.22%)
Total liabilities / Total Assets > .5	1.40% (0.87%)	-2.35% (0.75%)**
Capital / Employee > $100,000	-0.02% (0.93%)	-1.02% (0.74%)
Current Assets / current liabilities < 1.5	0.94% (1.00%)	-1.91% (0.87%)*
Year > 1989	-0.15% (0.82%)	0.09% (0.77)%
Rival characteristic		
Employees < 500	1.06% (1.19%)	-1.37% (1.07%)
R&D / Sales > .15	0.23% (1.62%)	0.81% (0.97%)
Total liabilities / Total Assets > .5	-0.15% (0.86%)	-0.35% (0.80%)
Capital / Employee > $100,000	-0.99% (0.95%)	1.02% (0.74%)
Current Assets / current liabilities < 1.5	1.69% (1.11%)	1.19% (0.86%)
Firms in same SIC4 primary industry	2.67% (1.16%)**	-0.61% (0.89%)
Sample: All alleged infringers		
Firm characteristic		
Employees < 500	-1.70% (0.92%)*	
R&D / Sales > .15	-1.79% (0.80%)*	
Total liabilities / Total Assets > .5	0.05% (0.33%)	
Capital / Employee > $100,000	-0.26% (0.44%)	
Current Assets / current liabilities < 1.5	0.11% (0.34%)	
Year > 1989	-0.56% (0.32%)*	
Patentee is public firm	-0.12% (0.35%)	
Industry		
SIC = 28 (chemicals, inc. pharma)	-0.41% (0.41%)	
SIC = 35,36,73 (electronics, computer,sw)	0.06% (0.38%)	
Other manufacturing	0.16% (0.33%)	

Note: Standard errors in parentheses. Single asterisk indicates difference is statistically significant at the 5% level; double asterisk indicates 1% significance (one-tailed test allowing unequal variances and using Satterthwaite's calculation for degrees of freedom). Average cumulative abnormal returns are weighted means, with weights proportional to the inverse of the estimated variance of each return. Matched sample comparisons are for cases where infringement is known and no possibly confounding events have been found.

Table 5. Attorneys' Fees Awarded in Patent Lawsuits (in millions of year 1992 dollars)

	Mean	Median	Observations
Patentee Litigant			
Summary Judgment	.95	.40	8
Verdict	1.04	.78	51
Alleged Infringer			
Summary Judgment	.57	.30	10
Verdict	2.46	.98	18

Table 6. Measures of Infringement Risk, Public Firms

	Aggregate Annual Cost of Litigation to Alleged Infringers (billion $92)	Annual Firm Infringement Risk (million $92)	Aggregate Risk / R&D
1984	2.0	1.3	4.9%
1999	16.1	7.0	19.3%
1996 - 99			
All firms	14.9	4.5	14.0%
Small firms (employees <500)	0.1	0.1	1.3%
Large firms (employees>=500)	14.8	9.8	14.9%
SIC = 28 (chemicals, inc. pharma)	3.4	9.7	14.1%
SIC = 35,36,73 (electronics, computer, software)	6.8	5.7	14.8%
Other manufacturing	1.7	2.3	5.3%

Note: Annual cost of litigation is the mean CAR times the market capitalization of each firm's common stock divided by a GDP deflator and by the aggregate Tobin's *Q* (market value divided by replacement value of capital including R&D). Firm infringement risk is the expected annual cost of litigation. Column 1 includes all events in the large sample (2,887) with separate means for small firms and lawsuits with multiple defendants. Columns 2 and 3 have been adjusted for under-reporting of lawsuits (see Lanjouw and Schankerman 2004 and Bessen and Meurer 2005).

Figure 1. Histograms of Cumulative Abnormal Returns

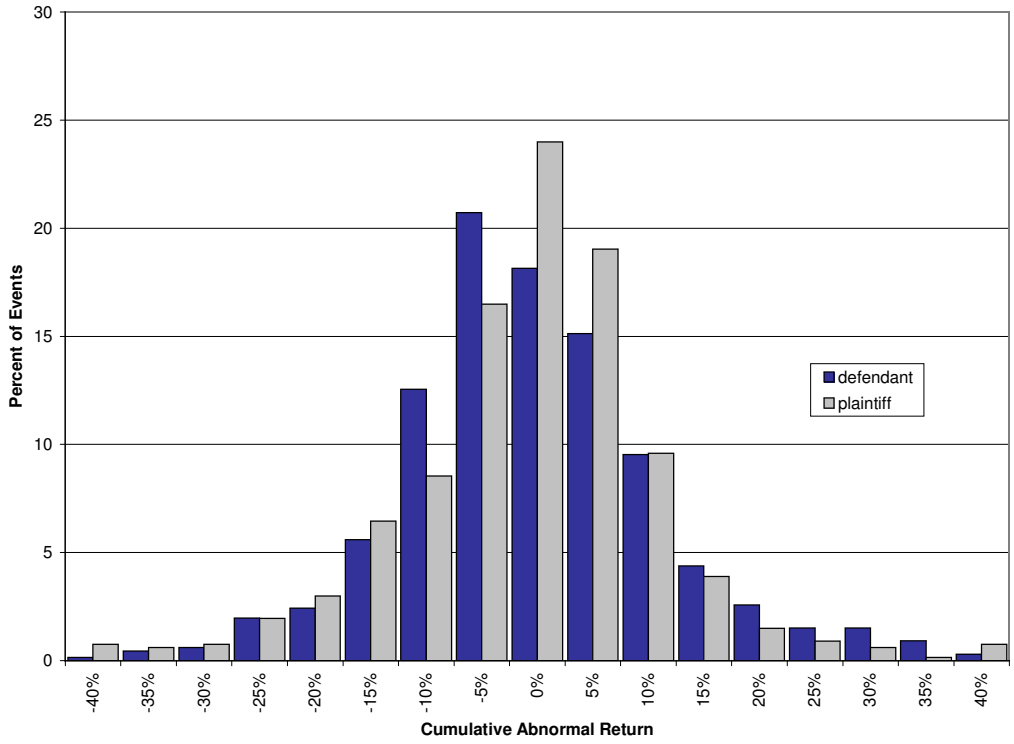

Figure 2. Aggregate annual cost of patent litigation to alleged infringers