

THE EFFECTS OF PATENT LITIGATION ON UNIVERSITY LICENSING EFFORTS

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Abstract

One of the effects of increased licensing activity at universities over the past 20 years has been a rise in the use of lawsuits by universities to enforce their intellectual property rights. In this paper, we ask: “*What effects does patent litigation have on university efforts to license technology?*” We find that patent litigation has an adverse effect on overall university licensing activity because it takes time and attention of licensing officers away from marketing technologies and establishing licenses. Given the adverse effects of litigation on licensing, we investigate why universities litigate. We conduct interviews with directors of technology licensing offices at 13 Carnegie I research universities and conduct a quantitative examination of 116 Carnegie I research universities from 1991 through 2000. Universities litigate when they are larger and can amortize the distraction of litigation across more officers; if they are less reliant on industry funding and can take a more aggressive posture towards private firms; if they have a greater base of royalty income; if they have more licensing and litigation experience, and if they license less exclusively.

I. INTRODUCTION

One of the changes that have accompanied the increased growth of licensing at universities since the passage of the Bayh-Dole Act almost 25 years ago has been an increased use of lawsuits by universities to enforce their intellectual property rights. The University of California, for example, recently settled a lawsuit with biotechnology firm, Genentech for \$200 million because Peter Seeburg, a post doctoral researcher at the University of California at Berkeley violated the university's patent for the production of human growth hormone by bacterial synthesis when he took a clone from his university lab to Genentech when he began employment there. Similarly, the University of Minnesota settled its dispute over patents covering Glaxo Wellcome's AIDS drug Ziagen with a multi-year licensing deal estimated to be worth \$300 million.

Of course, universities do not always win these lawsuits, making them costly and uncertain activities. Take, for example, the University of Rochester's recent lawsuit to enforce its cox-2 inhibitor patent against pharmaceutical companies Pfizer and Merck. The university is now appealing a federal judge's ruling that the patent was invalid, which stymied its attempts to obtain hundreds of millions of dollars in royalties.

Aggregate statistics illustrate the increasing use of patent litigation by universities. As Figure 1 shows, university patent litigation increased substantially through the 1990s, at a pace consistent with the overall increases in patent litigation in the United States (Merz and Pace, 1994; Somaya, 2004). Despite the increasing use of litigation by universities as a way to protect their patent rights, there has been no research that has examined the role of patent litigation in the university technology licensing process.

An examination of this topic would be beneficial in three ways. First, this investigation allows us to understand an important part of universities' strategic behavior and its impact on the national innovation system. Universities are important contributors to private sector innovation (Adams, 1990; Jaffe, 1986). As a result, their decisions about the creation and dissemination of technology are important to understanding the national innovation system (Nelson, 1993). Because university technology transfer has become a billion dollar business and has transformed attitudes among university administrators towards commercial activities (Shane, 2004), understanding strategic university activities, such as patent litigation, are important if scholars are to understand university licensing and technology commercialization processes and their role in the national innovation system.

[INSERT FIGURE 1 ABOUT HERE]

Second, our study allows us to evaluate whether the incentives provided by the Bayh-Dole Act are too strong given the different goals of universities and policy makers. The purpose of the Bayh-Dole Act, which gave universities the property rights to federally-funded inventions, was to encourage private sector commercialization of academic inventions, not to provide universities with an additional mechanism to generate revenues. However, university administrators report that revenue generation is a major goal of their technology transfer operations (Thursby, Jensen and Thursby, 2001). Given the different goals of policy makers and university administrators toward

² The propensity of university patent litigation with respect to contemporary patent issuances is around 13 suits per thousand patents, which is approximately the same (14 per thousand) as that for all U.S. patents (Lanjouw and Schankerman, 2001). This result is a bit of a surprise since university patents are widely believed to be more valuable (see for example, Henderson, Jaffe and Trajtenberg (1998) who find that university patents are more heavily cited than commercial patents), and would therefore be expected to experience more litigation. However, this finding is consistent with our interview evidence that universities generally shy away from patent litigation.

technology licensing, quantifying the effect of university patent litigation on technology transfer activities is important to making accurate policy decisions. Federal policy toward university intellectual property needs to consider whether allocating property rights over federally funded inventions to universities reduces technology licensing activity and, hence, technology transfer to the private sector by giving universities too much of an incentive to protect those rights through litigation. If so, the incentives provided by the government may be too strong because they lead to strategic actions that result in less than the optimal amount of university inventions being licensed.

Third, university patent litigation provides a unique opportunity to quantify the organizational costs of patent litigation. Prior research has argued that patent litigation is costly to organizations because, in addition to pecuniary legal costs, it is a significant disruption and takes people's time and attention away from other important activities (Somaya, 2003; Walsh, Arora and Cohen, 2003). However, these organizational dislocation costs have never been quantified, in part because it is difficult to obtain data that measure these costs. We are able to address this lacuna in the context of university patent litigation because the dislocation costs imposed by litigation are relatively well contained within the technology transfer offices and quantitative performance data are available for the activities of these offices.

This paper has two sources of empirical data. First, we conduct interviews with the directors of technology licensing offices at 13 Carnegie I research universities to understand why they litigate to protect their patents and what effect this litigation has on technology licensing office operations. Our interviews indicate that lawsuits are more likely to occur when the university has generated more royalties from previous

technology commercialization activity, when the university is less reliant on industry research funding, and when licensing offices are larger, more experienced, and rely more heavily on non-exclusive licensing. Our interviews also indicate that litigation imposes significant costs on university licensing activity. While litigation has little effect on the ability of universities to obtain invention disclosures or file patents, it reduces the amount of licensing officer time available to market technologies to private companies and form licensing agreements with them.

Second, we analyze statistically the relationship between university patent litigation and university licensing activity, and find patterns that are highly consistent with our interview findings. Using data on 116 U.S. universities from 1991 through 2000, we examine the correlations between the number of days of university patent litigation in the prior year, and the number of new licenses, new disclosures and patents applications filed in a given year. Controlling for a variety of factors in a fixed effects model, we find that more patent litigation by a university in the prior year reduces the university's level of licenses executed, but not its level of patent applications or invention disclosures. We also examine statistically the relationship between attributes of universities and their time spent litigating patents. Controlling for a variety of factors, we find that universities with larger technology licensing offices, less exclusive licensing, less industry funding, and more royalties, engage in more patent litigation.

II. The Data

The Qualitative Data

We gather data from interviews with 13 directors of technology licensing offices at Carnegie-I research universities to gain a thick description of the process by which universities decide whether to litigate against patent infringement and the effects of that litigation on technology licensing activity. To gather the interview data, we sent requests to 16 randomly selected directors of technology licensing offices. Of these, 13 agreed to participate in the study.

The interviews were structured and followed a written interview protocol. They lasted between 30 and 45 minutes. All interviews were tape recorded and transcribed. We worked from the interview transcripts to conduct the qualitative analysis.

The Quantitative Data

We use data from the annual survey of the Association of University Technology Managers (AUTM), which gathers data annually from U.S. and Canadian universities and hospitals about their technology transfer activities.³ To minimize potential confounds, we restrict our analysis to U.S. universities only. Because AUTM has gathered data on licensing activity since 1991, we explore the relationship between litigation and licensing over the period 1991-2000. The AUTM surveys are based on activity that occurred during university academic years, which run from July through June – e.g., the academic year 1998 runs from July 1, 1998 through June 30, 1999. We therefore conform all our data and analyses to academic years.

³ AUTM Licensing Survey (Various editions: FY1994-2000), Association of University Technology Managers, Northbrook, IL, © 1996-2002. The FY 1994 edition contains data going back to 1991.

⁴ AUTM Licensing Survey (Various editions: FY1994-2000), Association of University Technology Managers, Northbrook, IL, © 1996-2002. The FY 1994 edition contains data going back to 1991.

Because we employ panel data techniques in our analyses, our sample is restricted to the 116 U.S. universities for which data from at least two years is available. Of these institutions, 56 have participated in all ten years of the survey, and 74 have participated for at least eight. Virtually all the significant U.S. research universities, accounting for over \$25 billion of sponsored research in 2000, participate in the AUTM survey. Our sample of universities produces almost all of the academically generated intellectual property in the United States.

Our study defines a university as an institution of higher education that operates under a single set of policy rules. Therefore, we combine data from multiple campuses of the same university into a single university entity unless the university operated the different campuses according to different technology licensing policies. Because we are unsure about the right aggregation strategy to use for the various campuses of the University of Texas, we excluded it from our analyses.

Although most of our variables were obtained directly from the AUTM survey, our measure of litigation was obtained from secondary sources. We relied on two main sources of patent litigation data – the U. S. Patent and Trademark Office (USPTO) Litalert database, and Federal Judicial Center (FJC) database of U. S. Federal Civil Litigation.⁶ These sources overlap substantially in their coverage, and have been discussed in detail elsewhere (Lanjouw and Schankerman, 2001; Somaya, 2003). For the purposes of this study there are two main differences between them. First, the USPTO database contains only a subset of the suits (about 56% of the suits) reported in the FJC database. Second, the USPTO database contains more comprehensive data about the

⁵ The USPTO database was kindly provided by Derwent Information®.

⁶ Federal Judicial Center. Federal Court Cases Integrated Database (various versions, 1970-2000), Ann Arbor, MI: Inter-university Consortium for Political and Social Research (distributor).

parties involved in a suit, whereas the FJC database only reports the first plaintiff and first defendant. We compensate for the lack of complete party-related information in the non-overlapping subset of FJC cases through searches for news articles about university patent litigation in Lexis-Nexis. We complement these data sources by collecting data on patents issued to the universities in our sample to examine trends in overall patent stocks and the distribution of patents among technologies.

The parties involved in patent litigation in the FJC and USPTO datasets were searched for common university-related search strings such as “Univ”, “Colleg”, “Regent”, and “Trustee”. In addition, different name variations for each university were also searched (e.g. “Purdue”, “AZ State”, “Arizona”). Extensive searches on Lexis-Nexis for news articles relating to university patent litigation informed our choice of search strings, which were interactively refined and improved by examining why some cases of University patent litigation (found on Lexis-Nexis) were not initially picked up by our searches. Ultimately, this process produced a probable list of over 12,000 suits. Because we erred on the side of inclusion with our search strings, the rate of false positives was very high. These false positives were removed by manual examination of the suits.

Using the same methodology, we also searched for suits that involved either Research Corporation or University Patents Inc. – the two main university patent management firms – as one of the parties. Further, by using the USPTO dataset, we were also able to identify a number of suits relating to patents that were assigned (when issued) to universities, but did not include the university as one of the litigating parties. Since exclusive licensees can, by law, engage in the enforcement of patents, we interpret these suits as being licensee-driven. We complemented these “licensee-only suits” with similar

suits from our news searches when we found university patents being enforced by licensees. While we could use the FJC dataset (which contains nearly the entire population of patent suits) to obtain the corresponding litigation record for suits identified elsewhere, we could not directly search the FJC data for licensee-only suits or for suits where the university is not the first litigant.⁷

From the process described above, we identified 315 patent suits involving AUTM universities that were active in any academic year from 1987 to 2000. We define “active” suits in any given year as those suits whose dockets were open for any fraction of that year. Thus, a suit is active in its filing and ending years, as well as all intermediate years between them. Among these 315 suits, 235 suits involved the university as a litigant, while 80 were licensee-only suits. Further, 32 suits did not involve commercial firms as a counter party (to the university) in the suit, which we call “non-company” suits, and exclude from our analysis.⁸ This left 203 suits where universities engaged in patent litigation with companies (“with-university” suits).⁹

In Figure 1, it is evident that while litigation by universities has been increasing, licensees are taking on an increasing role in the enforcement of university patents. Table

⁷ This is on account of the somewhat more limited information (first litigants only) available in the FJC data. The associated concern of obtaining a biased (and incomplete) sample of litigation is mitigated by our exhaustive searches for news articles. Since we have an estimate of the incompleteness of the USPTO sample, we know that we have accounted for most of the litigation not reported there.

⁸ Since university are always the patent owners in these suits, the implication of their being defendants is that these are declaratory judgment suits that are proactively brought by putative infringers against the university (and/ or its licensee). In our analyses, we do not differentiate between these suits and those brought by the university. This approach is supported by the practicalities of patent litigation – declaratory judgment suits require a showing of immediate threat from litigation and patentees typically respond to them with counter-claims of infringement.

⁹ The non-company suits in our sample primarily involved individuals, except in 5 cases where they involved other Universities or non-profits. Typically, these suits are about a claim of co-ownership of the patent, and are of a qualitatively different type than the suits involving companies. For example, in 60% of these non-company suits, the University is the defendant in the suit, whereas the corresponding figure for the remaining suits is 16%. Moreover, these suits are extremely unlikely to impinge on the working or effectiveness of the University Technology Licensing Office since they are not directly related to any technology licensing activity.

1, which compares patent litigation with patent issuances for the 74 universities for which we have at least 8 years of AUTM data, indicates that the ratio of university patent litigation to patent issuance is about 12-13 suits per 1000 patents issued, which is similar to the litigation propensity for all U.S. patents (about 14 per thousand) (Lanjouw and Schankerman, 2001). This is a bit of a surprise since university patents are widely believed to be more valuable – see for example, Henderson, Jaffe and Trajtenberg (1998), who find that university patents are more heavily cited than commercial patents – and would therefore be expected to experience more litigation. However, this finding is consistent with our interview evidence that universities generally shy away from patent litigation. There appears to be no significant change in the litigation propensity over time.

[INSERT TABLE 1 ABOUT HERE]

We measure the effect of patent litigation on universities by counting and adding up the number of days that a university is involved in separate patent suits in each year. Sometimes, patent litigation in the same dispute – i.e. between the same parties and over the same patent – can span many suits.¹⁰ In these cases, we combine all of these suits into a “litigation unit” that starts from the first date of the first suit filed to the last date of the last suit to end.¹¹ We sum up the number of days a university engages in distinct litigations in any given year, and transform this variable into litigation-years (dividing by 365) for ease of coefficient interpretation. To clarify, the litigation-year variable can be greater than “one”, so that if a university experiences two patent litigations that each last

¹⁰ These multiple suits can arise from suits filed in different district courts, or from the re-opening of closed dockets.

¹¹ All our analyses are conducted using data at the litigation unit level, but we have also replicated them at the suit level (i.e. using suit-years instead of litigation-years), and find very similar results.

the entire year, this will be measured as two litigation-years for that university. Our measure, *Licensee-only litigation* measures the number of litigation years of suits filed only by licensees. *University-led litigation* measures the number of litigation years of suits led by universities. We also code two indicator variables for the end of a lawsuit. *End of lawsuit (current)* measures the number of lawsuits over a patent that ended in the year of observation.¹² *End of lawsuit (prior)* measures the number of lawsuits that ended in the year before the year of observation. *Prior litigation* measures the number of patent litigations in which the University was involved prior to a given year.

Most of the remaining variables are taken from data reported by universities in the AUTM survey. *New licenses* is a count of the number of licenses (and options) executed by the university in the year of investigation. Similarly, we also use counts of *new licenses to small/ start-up firms* and *new exclusive licenses*, but these variables were only collected by AUTM for the five years 1996-2000. *New invention disclosures* is a count of the number of new inventions disclosed by inventors to the university in the year. *Research funding* is the dollar value of the universities' research and development expenditures from all sources, and *Industry funding share* is the fraction of these funds that are obtained from industry sources. *TLO staff FTEs* is the number of full time equivalents (FTEs) employed in the university licensing office in a given year, an estimate of the size of the office. *Gross royalties* is the total dollar value of royalties obtained by the university in a given year.

¹² In some instances, more than one patent litigation ends in the same year. The end-litigation variable is therefore not a 0/1 dummy variable.

¹³ All our analyses are conducted using data at the litigation unit level, but we have also replicated them at the suit level (i.e. using suit-years instead of litigation-years), and find very similar results.

We measured the *Exclusive licensing share* as the fraction of the university's licenses that were exclusive over all years for which this data was available. Since the AUTM surveys collected exclusive licensing information for only four effective years of our data, we were unable to compute stocks of exclusive licenses, and rely instead on an average measure that accounts for the overall propensity of a university to engage in exclusive licensing. There is substantial variation in this measure between universities. Similarly, the *Small firm licensing share* is also computed as the fraction of the university's licenses over all years of observation that were made to small and start-up firms.

We use U.S. patenting data collected for all universities in our sample to measure the industry distribution of patents by major technology classes. We calculated the percentage of the five year stocks of patents belonging to each university into five commonly used technology classes (Jaffe, Fogarty and Banks, 1998) – *Electrical and Computer, Drugs and Medical, Chemical, Mechanical, and Other*. We use the fraction of Mechanical patents as the omitted variable in our analyses because mechanical patents have approximately the same propensity of litigation as the average patent in U.S. patent litigation (Somaya, 2004). Because we set the percentages equal to zero for those universities with no patents during the observed period, we also include a dummy variable of one if the university had *Zero patents* during the period. We also use a dummy variable for universities that have a *medical school*, and a variable that measures the age of the university technology office in the year 2000 (*office age*).

II. EVIDENCE ON THE EFFECT OF LITIGATION

The Qualitative Evidence

We summarize the evidence we obtained from interviews with directors of technology licensing offices at 13 universities in the sections below. Illustrative quotes from our interviewees that support our summary findings are included in tabular form. Overall, our interviews indicated that patent litigation is a relatively rare event for many universities, and therefore involves a departure from mainstream activities of the licensing office.

The Effect of Different Types of Lawsuits

Our interviews sought to understand the differences in the effect of licensee and university led lawsuits on the operations of a technology transfer office. Our interviews indicated a preference on the part of universities for not filing lawsuits themselves to enforce their patent rights, and for licensees to conduct the litigation instead. Despite this preference to have licensees enforce their patents for them, universities admitted that they occasionally do initiate patent lawsuits for various reasons that we explore in a later section. In fact, as Figure 1 shows, universities are much more likely to participate in patent litigation than to let licensees enforce their patents. Nonetheless, as Table 2 indicates, the interviewees indicated that licensee-led lawsuits have little effect on the operations of a technology licensing office, which explains their preference for this form of patent enforcement. The increasing share of licensee-led litigation illustrated in Figure 1 is consistent with this preference.

[INSERT TABLE 2 ABOUT HERE]

The Effect of University-Led Lawsuits

While the technology licensing office directors indicated that university-led lawsuits were costly in terms of the time and effort of licensing office personnel, this cost was not evenly distributed across all licensing office activities. The licensing office directors explained that lawsuits tend to have most of their adverse effects on efforts to market new licenses and collect royalties on existing licenses because that activity is the most discretionary in a technology licensing office. The respondents indicated that litigation tended not to affect efforts to obtain invention disclosures or file new patent applications.

As Table 3 summarizes, the licensing office directors explained that litigation had an adverse effect on technology licensing office activity when the university led the litigation. The main adverse effect of university-led lawsuits is opportunity cost of technology licensing office time that could be spent on other activities. University technology licensing officers report that they do not have enough personnel to effectively market all of their invention disclosures (Thursby et al, 2001). In fact, the typical university licenses only about half of its patented inventions (Shane, 2004).

[INSERT TABLE 3 ABOUT HERE]

The marketing of university inventions is time consuming because the technologies are typically very early stage and the modal number of interested licensees is low (Shane, 2004). The limited development of technologies means that licensing offices must contact prospective licensees directly to see if they would be interested in licensing the invention (Shane 2004; Hsu and Bernstein, 1997; Thursby et al, 2001).

Presumably, any factors that reduce the time and attention that licensing officers can devote to marketing should reduce technology licensing. When universities are

involved in patent litigation, the time that ordinarily would be spent engaging in these activities instead must be spent on activities related to the lawsuit. Licensing officers must organize records so that they may be made available to the legal team. They must meet with in house and external counsel. They must provide depositions. The technology licensing office directors estimate that a typical licensing officer who is responsible for a patent that is subject to an infringement lawsuit will spend approximately 20 percent of his or her time on the patent litigation, time that is no longer available to increase the marketing and licensing of inventions.

As Table 4 summarizes, university technology licensing office directors believe that university-led litigation hinders technology licensing. The respondents indicated that the high opportunity cost stemmed from the heavy involvement of the technology licensing officers in the litigation process, although several of the interviewees also explained that lawsuits are costly because they are stressful and therefore disruptive to the operations of the office as a whole. The licensing office directors pointed out that the process of discovery is a particularly time consuming and disruptive aspect of litigation.

[INSERT TABLE 4 ABOUT HERE]

As Table 5 summarizes, litigation has little effect on the ability to receive invention disclosures, largely because licensing officers spend little time obtaining invention disclosures. Licensing officers rarely search for invention disclosures, and instead expend their scarce time on patenting, licensing and enforcing licensing agreements (Owen-Smith and Powell, 2001). Moreover, the licensing offices rarely advertise their litigation within the university, and most of the directors of the offices that

we interviewed do not believe that inventors are aware of university patent litigation. Hence, inventor efforts to disclose invention are not influenced by litigation.

[INSERT TABLE 5 ABOUT HERE]

As Table 6 summarizes, litigation has little effect on patent filing. In many institutions, patent filings are outsourced to patent attorneys or delegated to dedicated personnel, whose work is not affected by litigation. In addition, patent applications have deadlines and are actively pursued by the inventors, which make it hard for licensing officers to cut back on patent filings.

[INSERT TABLE 6 ABOUT HERE]

The Quantitative Evidence

We also examined the impact of university litigation on TLO activity through the use of fixed effects regressions to predict the number of licenses issued, royalties received, patents filed, and disclosures received as a function of the number of patent litigation-years for an unbalanced panel of 116 universities across the 1991 to 2000 period. We use fixed effects models because we are concerned about the inconsistency of estimates due to omitted variables, and have virtually the entire universe of significant research universities rather than a sample drawn from a population. Further, Hausman's tests for random effects indicate that the unit-specific "error terms" are correlated with the regressors, which further supports our choice of models. We largely stay within the regression framework because we wish to address known concerns about autocorrelation in the errors.¹⁴

¹⁴ Our dependent variables are generally much larger than zero even though they are often count variables, so our judgment is that count models will not add much to our analysis.

Table 7 provides descriptive statistics. Table 8 provides the fixed effects regressions to predict the effect of patent litigation. We examine five models, each of which estimates the effect of litigation¹⁵ and various control variables on a dependent variable in the following year. Our use of lagged predictor variables is supported by our interviews and because we wish to rule out reverse causality. The first model estimates the impact of litigation on the creation of new licenses, controlling for the university's level of invention disclosures, share of industry funding, and the size of the technology licensing office in full time staff, the proportion of inventions in different technology areas, and dummy variables for the year of investigation.¹⁶

[INSERT TABLE 7, AND 8 ABOUT HERE]

Consistent with the qualitative evidence from the interviews, Model 1 shows that each litigation-year spent in patent enforcement in the prior year reduces the number of new licenses issued in the subsequent year by about 5 licenses, a decrease of 18 percent at the mean level of licensing. Moreover, we find that the end of a lawsuit has no statistically significant effect on the number of licenses issued in the current year. The end of a lawsuit in the year prior to the lagged variables – in effect, two years before the year under investigation – has a statistically significant positive effect on the number of new licenses issued. This suggests that there may be some “catch-up” by the licensing office on its workload from the litigation years.

Based on the average length of litigation in our sample of university patent suits (18.5 months), the magnitude of this catch-up (5.23 licenses) is smaller than the negative effect of university-led litigation on new licenses (7.42 licenses). However, given the

¹⁵ We obtain qualitatively the same results when we measure the number of active lawsuits in place of the number of days of litigation.

¹⁶ We obtain qualitatively the same results with a time trend variable as with year dummy variables.

standard error of the net difference in licenses (4.32), we cannot reject the hypothesis that the licensing office “catches up” by two years after the litigation.

Model 2 examines the effect of litigation on new licenses executed with new and small firms, controlling for the same factors as in Model 1. This regression uses a much shorter panel than Model 1 because data on licenses to new and small firms were only collected for five years (1996-2000). We observe again that the effect of university litigation on new (small and start-up) licenses is negative, and appears to account for almost all the decrease in the overall level of new licenses. Each litigation-year in the prior year reduces the number of new licenses to small firms and start-ups by about 6.1 licenses, a decrease of 35 percent at the mean level. Our finding of strong effects on licensing to small firms (and none with licensing to large ones – not reported) is consistent with some of our interview responses, which suggested that smaller firms needed significantly more hands-on work in both prospecting for and concluding licensing deals.

Again, even when we control for catch-up after the end of the lawsuit(s) in the two prior years, we find that the magnitude of the net catch up (1.6 licenses) is smaller than the negative effect of university-led litigation on new licenses to new and small firms (9.26). However, we again cannot reject the hypothesis that the licensing office “catches up” by two years after the litigation, given the standard error of the net difference in licenses (5.76).

The third and fourth models respectively examine the effect of litigation on new patent filings and invention disclosures, controlling for the same factors as in Model 1 (except in the model for disclosures, where research funding replaces disclosures as a

control variable). Consistent with the qualitative evidence from the interviews, we observe no significant relationship between the time spent by universities in patent litigation and the number of patents filed or disclosures in the subsequent year.

Model 5 examines the effect of litigation on new exclusive licenses executed, controlling for the same factors as in Model 1, again using a shorter panel of five years (1996-2000). One litigation-year of patent litigation in the previous year decreases exclusive licenses executed by 11.7 licenses, a decrease of about 83% at the mean level of exclusive licensing. Moreover, when we control for the catch-up effect (6.19 licenses) after the lawsuit ends, the magnitude of the net decrease in exclusive licenses from an average patent lawsuit is very large (11.67 licenses). Based on the standard error of this net difference in licenses (5.00), we can reject the hypothesis that the licensing office “catches up” with its exclusive licensing by two years after the litigation. Thus, with exclusive licenses, universities cannot make up for the negative effects of university-led litigation even two years after litigation.

III. Evidence on Predicting Litigation

Given the negative effects of patent litigation on university licensing activity, we investigate why universities litigate to protect their intellectual property rights. Our interviews with the directors of technology licensing offices suggest five hypotheses. First larger technology licensing offices are more likely to litigate to protect patents. Second, universities are less likely to litigate when they receive greater industry funding. Third, royalties earned from prior licensing activity makes a university more likely to

litigate. Fourth, more experienced technology licensing offices are more likely to litigate. Fifth, universities that license more exclusively litigate less often.

Qualitative Evidence

As Table 9 summarizes, universities are more likely to litigate if they have generated significant royalties from past licensing. Even if a particular patent appears promising and could generate high levels of royalties if enforced, universities often do not litigate if they have not earned high levels of royalties from prior technology licensing. One reason for this is that universities are typically budget constrained, and are therefore reluctant to take money from their general funds to pursue highly uncertain patent litigation. Some licensing offices have the discretion to use their own royalty funds to enforce patents, thus allowing licensing offices that have built up prior reserves to litigate. Moreover, many of our interviewees argued that prior success with patent licensing, as measured by licensing revenues, builds up the credibility and organizational influence of the technology licensing office within the university. In turn, this enables the licensing office to obtain the backing, both financial and otherwise, of university administration for pursuing patent litigation.

[INSERT TABLE 9 ABOUT HERE]

As Table 10 summarizes, universities are more likely to litigate if they receive a greater proportion of research funding from the government, rather than from industry. Most technology licensing offices consider the overall costs and benefits to the university when they decide to pursue litigation, and solicit input from the university administration in making this decision. This means that they factor in impact of litigation on grants and

research contracts from industry. As a result, many technology licensing office directors indicated that specific companies are “off limits” in patent litigation because they are strong supporters of the university and its research. Few universities want to follow the negative example set by the University of Illinois in litigating intellectual property relating to the Mosaic web browser, only to lose the possibility of future donations from Netscape founder Mark Andressen (Reid, 1997). Moreover, universities that receive more of their funding from industry are also more likely to know how to resolve disputes with industry privately, and so do not let conflicts escalate to litigation.

[INSERT TABLE 10 ABOUT HERE]

As Table 11 summarizes, universities with larger technology licensing offices are more likely to litigate to protect their patent rights than smaller technology licensing offices because of their ability to manage the costs of litigation on existing office operations. The costs of litigation fall more heavily on small offices because of their inability to reallocate the work that licensing officers involved in litigation are unable to do. As a result, offices with fewer personnel¹⁷ are less likely to file lawsuits.

[INSERT TABLE 11 ABOUT HERE]

As Table 12 summarizes, universities that have more experience managing intellectual property than other universities are more likely to litigate. One reason why experience matters is that it helps licensing offices negotiate the organizational reluctance to pursue patent litigation and obtain backing from the university administration. In addition, universities are less likely to be concerned about the uncertainty and risk surrounding patent litigation if they are experienced in technology transfer and patent

¹⁷ Because we control for invention disclosures in the regression models, this effect of personnel is not just an effect of the size of an office’s invention pool, but is, instead, a measure of slack in the office workload.

litigation. Prior experience also leads university administrators to think that the adverse public relations from litigation is not problematic. Furthermore, experience increases the licensing office's ability to evaluate the university's legal case in an objective and impartial manner, leading to greater confidence in its ability to pursue patent litigation.

[INSERT TABLE 12 ABOUT HERE]

As Table 13 summarizes, universities that license more of their patents exclusively are less likely to litigate. The licensing office directors explained that when patents were exclusively licensed, they usually preferred to delegate responsibility for enforcing patent rights to their licensees. Non-exclusive licensees on the other hand have no legal *locus standi* in patent enforcement, which means that universities are virtually forced to enforce non-exclusively licensed patents themselves or abandon their claims on the technology. As a result, university-led litigation is less common when university patents are licensed exclusively and more common when universities engage in non-exclusive licensing.

[INSERT TABLE 13 ABOUT HERE]

Quantitative Evidence

For our unbalanced panel of 116 universities across the 1991 to 2000 period, we predict the number of litigation days as a function of TLO size (FTEs), share of industry funding, prior year royalties, age of the TLO, prior litigation experience, and exclusive licensing share. We control for the amount of technology production that the university had in the previous year with the number of its invention disclosures. We also control for whether the university had a medical school, given the tendency of biomedical inventions to be more heavily litigated. We control for the percentage of the university's prior

inventions that are in each of the five technological classes described earlier (mechanical engineering is the omitted category). Finally, we control for the proportion of licenses to small and start-up firms, and include a full set of year dummy variables.

For our main regression, we use random effects models because some of our hypotheses relate to variables that have no within-university variation, which would lead to misidentification if a fixed effects model were used. A random effects model also enables us to use information about inter-university differences in the other independent variables and obtain efficient estimates of their impact on the propensity to litigate. We complement these estimates with estimates from a fixed effects model that excludes some variables. To account for the large number of left-censored observations, we use Tobit models in each case.

Model 1 in Table 15 presents estimated coefficients from the random effects Tobit regressions that predict the amount of time a university spends in litigation (measured in litigation-years) in a year. Consistent with the results of our interviews, in Model 1, we find that larger technology offices engage in more litigation, controlling for the amount of disclosures produced by the university in the prior year. Each additional full time equivalent in a technology licensing office increases the number of days of litigation in the following year by 4.4 days, an amount equivalent to about 8.0 percent of the mean level of litigation.

[INSERT TABLE 15 ABOUT HERE]

Our interviewees also suggested that universities with closer ties to industry may be less likely to litigate. Our empirical results provide strong evidence that a higher proportion of industry funding at a university significantly reduces their likelihood of

patent litigation. Each additional percentage of industry funding (the mean is 10%) reduces litigation in the following year by about 16 days, equivalent to about 30 percent of the mean level of litigation.

We also hypothesized that universities with more royalties from technology licensing are more likely to engage in litigation than technology licensing offices with lesser royalties. Our interviews indicated that such licensing offices would have both the organizational credibility and the access to funds required to pursue patent litigation. Consistent with that argument, we find that each million dollars of additional gross royalties in the prior year (the average gross royalty is \$5.83 million) increases litigation by about 5.7 days, equivalent to about 10.4 percent of the mean level of litigation.

We hypothesized that more experienced technology licensing offices are more likely to engage in litigation. Our interviews indicated that experienced offices have developed a sophistication and level of understanding that less experienced licensing offices do not have. We measured the effect of technology licensing office age and age squared on the likelihood of litigation. The main effect of licensing office age is positive, but the effect eventually attenuates as suggested by the negative sign of the coefficient for age squared. However, at the mean age of University technology transfer offices (about 16 years in 2000), each year of experience increases litigation by net amount of about 22 days, equivalent to about 40 percent of the mean level of litigation.

The inverted U-shaped relationship of age to likelihood of litigation reaches its maximum for licensing offices that are 35 years old, or established prior to 1965. Because only 5 universities had technology licensing offices prior to 1965 in our sample, this suggests that the amount of university litigation likely reaches a plateau with age –

that is, it does not increase at the same rate with age for those universities that have older technology licensing offices.

Also consistent with our argument that more sophisticated offices engage in more patent litigation is the effect of prior litigation experience on the likelihood of litigation in the current year. Each prior patent lawsuit increases litigation by about 126 litigation days, equivalent to about 2.3 times the mean level of litigation. While this may suggest the possibility of unobserved heterogeneity among universities in our sample, the effect of prior litigation is just as strong in the fixed effects model (model 2).

The directors of technology licensing offices also felt that universities that rely more heavily on exclusive licensing should engage in less litigation due to “outsourcing” of their litigation to their exclusive licensees. Consistent with our interview evidence, we find that each additional percentage of licenses that are exclusive decreases litigation by about 3.3 days, which corresponds to about a 6 percent decrease in litigation at the mean level.

To complement our random effects estimates, we also report fixed effects Tobit regressions to predict litigation in Model 2. While we cannot test all of our hypotheses within the fixed effects framework, we do find results that are largely consistent with the random effects estimates presented above. Industry funding share has a significant negative effect on litigation, gross royalties and prior litigation have significant positive effects. The effect of TLO staff is signed in the right direction but is no longer statistically significant. We cannot test for the effect of exclusive licensing share and licensing office age, as these variables do not vary within each university.

VII. Conclusions

This paper represents the first empirical investigation of the role that patent litigation plays in the university technology licensing process. We provide both qualitative and quantitative evidence that university patent lawsuits reduce the amount of technology licensed by universities to the private sector. We find that the major adverse effect of patent litigation lies in licensing inventions exclusively and to new and small firms. We also provide both qualitative and quantitative evidence that universities are more likely to engage in patent lawsuits if they have fewer exclusive licenses, more staff, greater royalties, are more experienced, and rely less on industry funding.

Our findings are subject to a few important limitations. First, while we find support for organizational dislocation as the primary effect of patent litigation in both the interviews and quantitative data, we cannot rule out reputation or publicity effects.

Second, our quantitative data show a large positive effect of licensee-only litigation on university licensing. One interpretation of this effect is that licensee litigation has a positive reputation or publicity effect by showing that a university's intellectual property rights are valuable and being enforced. In turn, this may lead prospective licensees to seek out technologies and patents to license from that university. However, this does not mean that universities should enforce patents through their licensees, because the positive effect of licensee litigation might reflect unobserved heterogeneity in the types of patents litigated by universities and their licensees. In particular, licensees may be enforcing patents that they are actively commercializing, whereas universities may be enforcing "inactive" patents in the hope of appropriating royalties from alleged infringers.

Third, we have no explanation for why university licensing offices do not offset the demands of patent litigation by sufficiently increasing office staff or subcontracting some of its work. It is reasonable to assume that much of this work is very capability-intensive and requires organization-specific knowledge, which cannot be quickly built up or contracted out. Moreover, given the unpredictable nature of patent litigation, it may be extremely difficult to plan for such organizational needs in advance.

Nonetheless, our study takes a number of important first steps in investigating the phenomenon of university patent litigation. We provide the first direct quantification of the organizational costs of patent litigation. While many observers have argued that patent litigation takes an organization's time and attention away from other important activity, these organizational dislocation costs have never been quantified. The clearly defined scope of activities pursued by university licensing offices and the availability of quantitative data on these activities has enabled us to estimate these costs. We also find that these costs are mitigated to some extent because licensing offices catch up with some of their workload when litigation ends.

Perhaps more importantly, our empirical investigation allows us to understand an important aspect of the new strategic behavior exhibited by universities in the arena of technology transfer. Because universities are important contributors to private sector innovation (Adams, 1990; Jaffe, 1986), the substantial increase in the willingness of universities to engage in patent litigation has implications not only for universities and their operations, but also for the role of universities in the national innovation system.

In particular, our study allows us to evaluate whether the strategic actions of universities toward litigation are at odds with the goals of federal policy. The transfer of

property rights over federally funded inventions to universities under the Bayh-Dole Act gives universities an incentive to use the legal system to enforce those rights. Our results show that the enforcement of their property rights reduces the overall amount of technology licensed by universities because lawsuits hinder the marketing and licensing of technologies by resource constrained technology transfer offices. However, a wide range of studies indicate that universities have increased their licensing significantly in the wake of the Bayh-Dole Act, suggesting that the Act was useful in encouraging licensing activity. Because the policy goal of the Bayh-Dole Act was to encourage university technology transfer, the adverse side effect of litigation that we identify suggests that the property rights provided to universities under the Bayh-Dole Act may be too strong, generating less than the optimal amount of licensing by universities.

Moreover, assigning universities the rights to federally-funded inventions may provide incentives for universities to adopt strategies to maximize royalties rather than technology transfer. If effective patent litigation results in increased royalty generation by universities at the expense of total licenses generated, some technology licensing offices may adopt strategies to earn royalties through litigation even if that strategy reduces the amount of technology licensed to the private sector. Our results suggest that policy makers need to consider the adverse effects on technology licensing of the assignment of intellectual property rights to federally funded inventions to universities, and of the use of lawsuits as a mechanism to enforce those property rights.

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TABLE 2: THE EFFECT OF LICENSEE-LED LAWSUITS

University	Examples of the Respondents' Descriptions of the effect of Licensee-Led Lawsuits
D	“If we’re just a co-plaintiff, then there isn’t an awful lot that necessitates extraordinary effort on the part of our office”
G	“It doesn’t take much time away from the licensing office when the licensee handles it.”
K	“If there is a licensee and someone infringes then our licensee is going to be handling that and the university doesn’t get as involved....”

Key: Representative examples from the qualitative interviews conducted with 13 directors of technology licensing offices at Carnegie I research universities.

TABLE 3: THE EFFECT OF UNIVERSITY-LED LAWSUITS

University	Examples of the Respondents' Descriptions of the effect of University-Led Lawsuits
H	“There is an effect of litigation on the office. Litigation takes years. It is not over in two or three. I mean there’s a lawsuit at [University X] that has been going on for more than 10 years. It’s a continual drain on resources. It is multiple millions of dollars. You need someone involved in your office. You have a lot of long meetings. This is all extra, in addition to your normal workload.”
D	“Litigation takes up time that you could be devoting to other things.... If we are bringing suit ourselves, then there is a fair amount of time and energy involved....If there is a suit going on the particular licensing professional responsible for the patent and probably me will have a certain amount of time consumed with dealing with the suit. And whatever we’re engaged in is going to have to be reduced to some degree.”
E	“The effect of litigation adds up – an hour or two here and there....If you have a full year...there’s a ripple effect....And his or her boss, the director, might have to spend a quarter of that same percentage.”
K	“The expense of litigating can be a multiplier of two or three on top of what it already costs to operate the technology transfer office.... A huge amount of time is invested in assisting with the analysis of the litigation and then participating in the litigation, all of the pre-meetings and settlement meetings....Tech transfer is there as a representative of the academic administration and we have to dig up all of the files and make them available for copying and arrange all sorts of meetings and that kind of stuff.”
F	“Our technology transfer office needs to be intimately involved in terms of ... carrying through the whole process.... The TLO licensing officer tends to be the one that effectively acts as a coordinator, making sure the inventors is involved. The TLO officer essentially acts as the focal point for coordination of these efforts. In our lawsuit against [a major pharmaceutical firm], over a period of a year, that basically consumed my time. I didn’t do anything else for a year and a half.”
A	“In discovery, you’ve got to prove a lot of things. You’ve got to get the research notebooks. You’ve got to have the faculty available to do things. You might have to get depositions. So when you’re pretty well strapped trying to manage a couple of hundred disclosures a year with four people and now the university may be trying to do a hundred with two people, if anything is a distraction, it interferes.”
M	“It’s not a pleasant thing. It definitely has an effect on morale and productivity and our relationship with inventors.... If you have discovery, you have to get all the documentation and the correspondence together and that is a huge amount of work....You’re going to have to pull a lot of information out of the files and generate a lot of information to show. The people who you are suing are going to defend themselves and you are going to get an action back and you are going to have to produce a whole lot of documentation. Plus people might have to be deposed or appear before a judge.... And if they’re note going to be deposed you have to prepare for that anyway... So this is a lot of time and effort.”
I	“Lawsuits are very stressful. They are disruptive and counterproductive for the most part. The negative connotations that go along with it are demoralizing. It consumes what seems like lots of time.”
J	“Patent litigation consumes an enormous amount of everyone’s time and it can become very stressful for everyone involved....It diverts them from their normal duties to help manage the litigation. Your secretaries are going to be searching for records. Your data managers are going to be searching databases for information and documents and email....It becomes a time sink and a strain on the whole staff because of the amount of documents that you have to produce, the resources you have to use to respond to document production issues of depositions and being responsive to interrogatories. All this diverts you away from the ordinary business so it is a huge investment.”
L	“Filing lawsuits are a tremendous distraction. It takes a good bit of time to make the discovery and then there is the discovery.... I cannot imagine an office being involved in more than one active dispute at a time”

Key: Representative examples from the qualitative interviews conducted with 13 directors of technology licensing offices at Carnegie I research universities.

TABLE 4: THE EFFECT OF UNIVERSITY-LED PATENT LITIGATION ON LICENSING

University	Examples of the Respondents' Descriptions of the Effect of Patent Litigation on Licensing
I	"Licensing activities would be most affected.... Marketing leads to licensing so those are the two things that tend to suffer the most when they get busy or distracted."
D	"You're spending your time dealing with all the brouhaha on the litigation, you're going to have less time to be marketing and negotiating licenses."
A	"While you are litigating, you're not doing two license agreements because you're fighting this one. It can take a lot of your time."
B	"There's an effect on the productivity of the office when you're involved in a lawsuit because this person can't... market as many licenses."
K	"Litigation is such a distraction that it gets in the way of pursuing new business opportunities."
J	"The people that are handling the area of technology that is being litigated are going to have their time drawn away from what they otherwise would be doing in the marketing area.... Also to the extent that licensing officers are responding to the demands of litigation, that's going to slow down our approach to turning around agreements and getting them done."
F	"If there is a major litigation that tends to take a knock out of marketing new stuff or doing new license agreements. As a practical matter, disclosures keep coming in, patent activity still happens. A lot of these things are time sensitive and time driven. So if your time is limited, you've got to make sure that you're taking care of the time sensitive stuff. And some of the longer term or self-initiated things like marketing are probably the ones that fall by the wayside."

Key: Representative examples from the qualitative interviews conducted with 13 directors of technology licensing offices at Carnegie I research universities.

TABLE 5: THE EFFECT OF UNIVERSITY-LED PATENT LITIGATION ON INVENTION DISCLOSURES

University	Examples of the Respondents' Descriptions of the Effect of Patent Litigation on Invention Disclosures
D	"Getting disclosures just happens. While yes, there's a certain amount of outreach, getting disclosures happens. That's initiated by the inventors. It really isn't initiated by the office."
E	"You might have an effect on the one inventor who brings an infringer to us and thinks we should have gone after the infringer and we didn't. But overall, there would be no effect."
J	"There is less of an impact on disclosures and processing them."
B	"We're usually quiet about lawsuits so I don't think inventors know."
I	"For the most part, our faculty are not really aware of legal issues and would continue to disclose new technologies."

Key: Representative examples from the qualitative interviews conducted with 13 directors of technology licensing offices at Carnegie I research universities.

TABLE 6: THE EFFECT OF UNIVERSITY-LED PATENT LITIGATION ON PATENT FILINGS

University	Examples of the Respondents' Descriptions of the Effect of Patent Litigation on Patent Filings
J	"I don't think there is an impact on patent filings because most of our filings are done by outside attorneys."
E	"In many offices, you have dedicated administrative personnel who help to process the new patent filings, so there isn't that much of an effect of litigation on patent filings."
D	"Even during litigation, filing patents happens because you've got inventors who want their patent filed. So there's pressure on the office to complete that process."

TABLE 7: DESCRIPTIVE STATISTICS

Variables:	Mean	Std. Dev.			Min.	Max.	Obs.
		Overall	Between Univ	Within Univ			
New licenses	23.6	44.4	38.7	29.1	0.0	994.0	990
Licenses to startups & small firms	20.1	55.3	45.7	34.0	0.0	974.0	491
Exclusive licensing	14.1	18.4	15.4	9.2	0	248	496
New patents filed	28.9	39.8	31.7	21.9	0.0	432.0	980
Invention disclosures	75.4	92.2	81.8	37.8	0.0	999.0	995
University-led litigation year	0.11	0.42	0.28	0.31	0.00	4.30	1610
Licensee-only litigation year	0.06	0.31	0.20	0.23	0.00	5.12	1610
End of lawsuit	0.05	0.28	0.11	0.26	0.00	5.00	1610
Research funding	170.5	200.9	187.1	49.6	4.3	2084.6	998
Industry funding share	0.11	0.09	0.07	0.06	0.00	1.00	979
TLO staff FTEs	8.5	13.9	12.5	4.3	0.0	167.8	981
Gross royalties	4.3	13.7	9.6	9.1	0.0	267.8	995
Electrical and Computer	0.21	0.19	0.14	0.13	0.00	1.00	1610
Drugs and Medical	0.35	0.24	0.21	0.13	0.00	1.00	1610
Chemical	0.24	0.19	0.14	0.12	0.00	1.00	1610
Other	0.04	0.07	0.05	0.06	0.00	1.00	1610
Mechanical [omitted]	0.08	0.10	0.07	0.08	0.00	1.00	1610
Patent Stock [5 year]	58.2	108.3	91.3	58.9	0.0	1856.0	1610
Office age	16.0	11.9	11.9	0.0	1.0	75.0	1512
Prior litigation	0.58	1.50	1.36	0.63	0.00	11.00	1610
Exclusive Licensing Share	0.65	0.21	0.21	0.00	0.00	1.00	1090
Small Firm Licensing Share	0.63	0.15	0.15	0.00	0.24	1.00	1090
Medical school	0.59	0.49	0.49	0.00	0.00	1.00	1610

TABLE 8: FIXED EFFECTS REGRESSIONS PREDICTING THE EFFECT OF LITIGATION ON TECHNOLOGY LICENSING ACTIVITY

	Model 1	Model 2	Model 3	Model 4
	New Licenses (Mean = 23.6)	New/ small firm licenses (Mean = 20.1)	New patents Filed (Mean = 28.9)	New invention Disclosures (Mean = 75.4)
University-led litigation	-4.86 * (2.14)	-6.07 * (3.06)	-3.66 (2.62)	2.65 (3.68)
Licensee-only litigation	12.11 **** (2.85)	4.37 (4.22)	9.84 ** (3.448)	6.64 (5.43)
End of lawsuit	0.50 (2.02)	-2.25 (2.54)	0.39 (2.24)	-5.84 t (3.42)
End of lawsuit (prior)	4.73 * (1.96)	3.85 t (2.17)	-1.84 (2.17)	3.59 (3.30)
Invention disclosures	0.08 ** (0.03)	0.07 t 0.035	0.09 ** (0.03)	
Research funding				0.14 **** (0.03)
Industry funding share	0.49 (10.98)	-7.46 (21.54)	-0.16 (12.75)	19.28 (17.86)
TLO Staff FTEs	-0.52 *** (0.16)	0.73 t (0.40)	-0.65 (0.18)	0.16 (0.35)
Zero patents	2.69 (14.23)	9.10 (31.82)	-9.40 (18.02)	-32.31 (23.01)
Electrical and computer	-1.50 (15.37)	-12.84 (32.27)	13.16 (19.16)	-39.87 (24.83)
Drugs and medical	-4.01 (15.32)	-3.59 (31.43)	-10.50 (19.09)	-34.64 (24.82)
Chemical	-0.62 (14.20)	-2.31 (31.10)	-2.92 (17.65)	-41.29 (23.00)
Other	2.028 (27.20)	13.89 (47.72)	-23.70 (34.86)	-28.69 (42.85)
1993	-20775.6 (31949.75)		-1825.94 * (885.15)	-98606.32 * (42096.23)
1994	-8124.39 (12485.41)		-1136.16 * (546.45)	-39562.04 * (16883.83)
1995	-3174.00 (4872.70)		-706.15 * (334.28)	-15856.12 * 6761.75
1996	-1237.52 (1895.40)		-433.50 * (201.57)	-6333.44 * (2698.13)
1997	-480.87 (730.87)	-37365.58 (45718.12)	-261.67 * (118.38)	-2509.25 * (1066.61)
1998	-182.10 (275.40)	-6676.62 (8163.39)	-146.75 * (66.30)	-969.42 * (411.56)
1999	-66.21	-1167.14	-80.02 *	-350.97 *

	(97.35)	(1425.87)	(33.76)	(148.70)
2000	-19.5370	-179.50	-33.17 *	-102.90 *
	(27.54)	(217.07)	(13.21)	(42.90)
Constant	9.45	-18.04	5.46	16.34
	(7.56)	(30.11)	(5.67)	(11.86)
sigma_u	764.9502	1277.4895	130.76	
sigma_e	12.3435	10.1479	14.78	
rho	0.39	0.18	0.62	
R-square within	0.20	0.13	0.22	0.18
R-square between	0.00	0.01	0.01	0.01
R-square overall	0.01	0.01	0.04	0.01
F	7.44 ****	2.01 *	8.07 ****	6.24 ****
F test that all u_i=0	5.73 ****	6.54 ****	2.24 ****	6.70 ****
N of observations	704	342	700	702
N of universities	112	103	112	112

Key: Standard errors are in parentheses; t $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$ (Two-tailed tests) **** $p < .0001$ (Two-tailed tests)

TABLE 8: FIXED EFFECTS REGRESSIONS PREDICTING THE EFFECT OF LITIGATION ON TECHNOLOGY LICENSING ACTIVITY

	Model 5	
	New Exclusive Licenses (Mean = 14.1)	
University-led litigation	-11.71	****
	(2.59)	
Licensee-only litigation	20.73	****
	(2.94)	
End of lawsuit	5.50	*
	(2.24)	
End of lawsuit (prior)	0.69	
	(1.93)	
Invention disclosures	0.06	t
	(0.03)	
Research funding		
Industry funding share	6.17	
	(19.70)	
TLO Staff FTEs	-0.04	
	(0.22)	
Zero patents	1.51	
	(27.64)	
Electrical and computer	1.22	
	(27.97)	
Drugs and medical	1.42	
	(27.12)	
Chemical	-3.07	
	(26.80)	
Other	-0.18	
	(42.63)	
1993		
1994		
1995		
1996		
1997	57772.78	
	(263509.8)	
1998	6915.26	
	(31548.42)	
1999	817.99	
	(3734.97)	
2000	85.34	

	(400.12)	
Constant	20.8533	
	(43.2749)	
<hr/>		
sigma_u	1300.544	
sigma_e	9.2356	
rho	0.99	
R-square within	0.38	
R-square between	0.00	
R-square overall	0.01	
F	8.99	****
F test that all u_i=0	2.19	****
N of observations	359	
N of universities	104	
<hr/>		

Key: Standard errors are in parentheses; t $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$ (Two-tailed tests) **** $p < .0001$ (Two-tailed tests)

TABLE 9: THE EFFECT OF ROYALTIES ON PATENT LITIGATION

University	Examples of the Respondents' Descriptions of the Effect of Royalties on Patent Litigation
K	<p>“Universities have typically not considered litigation around tech transfer in whatever budget they hold aside to do these kinds of things. The resources aren’t budgeted for it and most universities work on an annual budget cycle. So when you come along and you have to come up with very significant resources to invest in litigation somebody has to find the money to do it. And if you’ve got the money you can pull it out of central’s share of the royalty distribution and that would make it easier.”</p>
E	<p>“The more successful a licensing office has been the more that you’re going to have support from the administration to have the university stick its neck out in tracking down an infringer. There’s a risk there. There is still some controversy about universities enforcing their IP rights in terms of public relations and the reputation of a university. If it’s been a successful office, you are going to have more support from the administration.”</p>
F	<p>“The office of general counsel is the one that ultimately has the authority to initiate a suit.... Your ability to generate royalties matters from a credibility standpoint.”</p>
G	<p>“If an office is bringing in \$100,000 in royalty income and they go to the president and say we want \$3 million to sue this company, that guy is going to say, ‘prove to me that there’s evidence that it has value’. But if you’re bringing in \$50 million in royalty income, you go to the president and say, ‘I need \$3 million to sue somebody’ then he’s going to say, ‘yeah, I know that technologies do have value.’”</p>
I	<p>“The decision on litigation is made at a very high level. I would say the vice president for research. To get him to agree it would be a good idea to have something in reserve so that there are resources available if they are needed. If a university has to go to generate such a budget item, it is tough to do.”</p>
J	<p>“There are not many offices that have the wherewithal to litigate. So if you’re part of a university, the money that you’re going to get for litigation comes out of the general fund. It’s easier to sell litigation to the administration of the university if you have made money off of patents.”</p>
L	<p>“There is an issue of credibility. If the office is deemed successful then we are going to have more credibility when we recommend to the president that we initiate a legal action.”</p>

Key: Representative examples from the qualitative interviews conducted with 13 directors of technology licensing offices at Carnegie I research universities.

TABLE 10: THE EFFECT OF INDUSTRY FUNDING ON PATENT LITIGATION

University	Examples of the Respondents' Descriptions of the Effect of Industry Funding on Patent Litigation
A	"I'm not going to send a scathing letter to Intel or Motorola who are funding research here and blow it on the possibility that they might be infringing....We don't go after someone that is a big researcher, that is some benefactor of the university... because that could come back to bite us."
B	"If we wanted to file a lawsuit, we would check with a lot of folks. We would see if there were any relations with the company from a development standpoint. We would check with sponsored research to make sure there wasn't a relationship with that particular company. Like we always joke in the office, we could never sue [a major computer manufacturer]. It would be politically impossible."
C	"You'll think that the Provost or the President or somebody ought to think about it before we sue one of our favorite friends.... I know of at least one case where a friend of [the university] complained loudly enough that we dropped an appeal after losing the first round."
K	"The unintended consequences analysis needs to come in. We have donors and all sorts of other consequences."
E	"If we have a good relationship with companies through sponsorship of a bunch of research or other things throughout the university, I think we are less likely to get into a dispute with them.... They know us and we know them and we're going to play nicely. We're not going to get into that litigation scenario with them or threaten litigation with them. So to the extent that we know people the less likely we are to have a dispute.... I cannot think of an instance where we have gotten down to sitting on the opposite side of a table with one of our research sponsors because we're accusing them of infringement. Those things usually get worked out if they're a company we have a relationship with....We're not going to get into a dispute with those people who we know anyway because they're going to say, 'yeah' and we're going to say, 'yeah, you know, maybe you should take a license.'"
I	"The university doesn't want to be suing our friends and supports and neighbors and fellow [name of the state] companies. If there is an issue, we would greatly prefer to sit down and discuss it and try to reach a resolution outside the legal system."

Key: Representative examples from the qualitative interviews conducted with 13 directors of technology licensing offices at Carnegie I research universities.

TABLE 11: THE EFFECT OF TECHNOLOGY LICENSING OFFICE SIZE ON PATENT LITIGATION

University	Examples of the Respondents' Descriptions of the Effect of Technology Office Size on Patent Litigation
D	“If you’ve got a large office, the whole group shouldn’t have their time taken up in dealing with the litigation. You don’t need to pull everyone into everything. But if the office is small - that means you have a director and two licensing officers – and one of those officers is spending a lot of time on the litigation and the director has to get pulled in, then essentially you’ve used up a major portion of your licensing office.”
K	“The smaller your office is, the more litigation is going to become an issue. Litigation becomes a priority and the deadlines have to be met. Everything else becomes discretionary relative to meeting those deadlines. So if you have a small office then the consequences become greater. You could literally shut down just about all additional business in a very small office while you pursued litigation.”

Key: Representative examples from the qualitative interviews conducted with 13 directors of technology licensing offices at Carnegie I research universities.

TABLE 12: THE EFFECT OF TECHNOLOGY LICENSING OFFICE EXPERIENCE ON PATENT LITIGATION

University	Examples of the Respondents' Descriptions of the Effect of Technology Office Experience on Patent Litigation
C	“There are universities that are inexperienced and would be afraid of lawsuits. There are universities that think much like Victorian ladies that getting in the paper is, by definition, a disreputable thing to have happen. I think of that as inexperience..... Also, if they’ve never done it before, it becomes a big hoopla particularly if the chancellor sees visions of \$50 million or \$200 million. The newspapers are calling you up and everything else.”
D	“Licensing offices that have been in business longer litigate more because you have to be sophisticated enough to realize that you are going to need expert assistance if you are going to pursue this course. And more experienced offices have more contacts and more context in which to place the whole prospect of litigation.”
E	You have some of the third parties out there wanting to blow you off and not get a license. More sophisticated offices are going to be able to track those instances and get people at the tech transfer office to pay attention to it and spend energy on it.”
G	The more sophisticate the office, the more likely they are to identify and take legal action because they have the ability to quantify potential value.”
J	“How long the office has been in operation is important in explaining why offices engage in litigation. It affects how knowledgeable the staff is and the level of advice that they are getting. If your office has been around only for a few years and the staff is relatively inexperienced, I don’t think that they are going to try to get involved in a patent litigation. If you’re an MIT or a Stanford, it may be more likely for you to do it because you understand the process a lot better and you’re more knowledgeable about it.”
K	“Making the decision the first time when your institution has not been through it before there are so many unknowns. It becomes easier to go through that mental thought process when the next opportunity rolls around.”

Key: Representative examples from the qualitative interviews conducted with 13 directors of technology licensing offices at Carnegie I research universities.

TABLE 13: THE EFFECT OF EXCLUSIVE LICENSING ON PATENT LITIGATION

University	Examples of the Respondents' Descriptions of the Effect of Exclusive Licensing on Patent Litigation
C	"When we have an exclusive licensee, we usually depend on them to enforce."
E	"Our licensees who take exclusive licenses have the right to enforce our patents. They're going to be doing that on their own."
B	"The reason we filed in the one or two cases it was not exclusively licensed [was that] it was our responsibility to maintain the patents or let those licenses go."
F	"In the case where we have a licensee that has an exclusive license we certainly have the ability to participate in the lawsuit. But I can't think of an instance where we have done so. We usually leave that to our exclusive licensee to pursue it."

Key: Representative examples from the qualitative interviews conducted with 13 directors of technology licensing offices at Carnegie I research universities.

TABLE 14: REGRESSIONS PREDICTING UNIVERSITY PATENT LITIGATION

	Model 1		Model 2	
	Random effects		Fixed effects	
	Litigation Years (Mean = 0.11)		Litigation Years (Mean = 0.11)	
TLO Staff FTEs	0.01 **		0.01	
	(0.004)		(0.008)	
Industry Funding Share	-4.52 ****		-4.77	****
	(0.99)		(1.35)	
Gross Royalties	0.02 **		0.02	*
	(0.005)		(0.008)	
Office Age	0.12 ****			
	(0.03)			
Office Age Sq.	-0.002 ****			
	(0.001)			
Prior Litigation	0.35 ****		0.36	****
	0.04		(.09)	
Exclusive Licensing Share	-0.89 *			
	(0.36)			
Small Firm Licensing Share	-0.22			
	(0.44)			
Patent Stock	-0.004 ****		-0.005	****
	(0.001)		(0.001)	
Zero Patents	0.39		2.72	
	(1.00)		(190.48)	
Electrical and Computer	0.39		-2.34	
	(1.07)		(1.87)	
Drugs and Medical	0.55		-0.30	
	(1.01)		(1.95)	
Chemical	1.53		0.70	
	(1.07)		(1.90)	
Other	0.76		-1.88	
	(1.73)		(2.73)	
Disclosures	0.004 **		0.003	
	(0.001)		(0.002)	
Medical School	0.01			
	(0.20)			
1993	-0.52		-0.46	
	(0.25)		(0.35)	
1994	-0.09		0.02	
	(0.22)		(0.30)	
1995	0.06		0.19	
	(0.21)		(0.27)	

1996	0.08		0.17	
	(0.21)		(0.25)	
1997	-0.11		-0.01	
	(0.21)		(0.24)	
1998	-0.22		-0.15	
	(0.21)		(0.23)	
1999	-0.20		-0.22	
	(0.19)		(0.20)	
2000	-0.31		-0.30	
	(0.19)		(0.19)	
Constant	-2.95		0.95	
	(1.15)		(2.39)	
<hr/>				
sigma_u	1.29			
sigma_e	0.72			
rho	0.76			
Log Likelihood	-394.95		-222.15	
Chi2	268.04	****	552.22	****
Pseudo R-square			0.55	
N of observations	805		805	
N of universities	105		105	

Key: Standard errors are in parentheses; t $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$ (Two-tailed tests) **** $p < .0001$ (Two-tailed tests)