Extreme Value or Trolls on Top? The Characteristics of the Most-Litigated Patents[1]

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Patent reform has become, perhaps improbably, one of the most contentious issues facing Congress and the courts over the past six years. The fights range across a number of major issues, separating not only patent owners from patent defendants or those who believe in innovation incentives from those who believe in market competition, but also dividing patent owners themselves along both industry and technology lines. Advocates on both sides paint seemingly irreconcilable pictures of the patent system, either as a stable system with clearly-defined legal rights that are essential to innovation or a system rampant with litigation abuse by "patent trolls" who use the legal system to divert money from innovative companies.[5]

Far too much of this debate is based on anecdote and assumption, not real data. Pharmaceutical patent owners assume that most of the world works the way their industry does; so too do information technology (IT) companies, in the opposite direction. Patent trolls

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[5] On these two views of the world, see **Dan L. Burk & Mark A. Lemley, The Patent Crisis and How the Courts Can Solve It** chapter 1 (forthcoming 2009).

are variously portrayed as responsible for the majority of all patent lawsuits, or for no more than 2%, or as mythical creatures that don't actually exist.[6]

The opening of the Stanford IP Litigation Clearinghouse in December 2008[7] allows us to collect data giving a unique perspective on many of these debates. We identify the patents litigated most frequently between 2000 and 2007, and compare those patents to a control set of patents that have been litigated only once in that period. The results are startling. The most litigated patents are far more likely to be software and telecommunications patents, not mechanical or other types of patents. They are significantly different from once-litigated patents in ways that signal their value up front. And they are disproportionately owned by non-practicing entities (aka trolls). The results don't answer all the policy questions; we offer only one important piece of a larger mosaic. But they have significant implications for debates over patent reform, since we show both that the most litigated patents are the most valuable ones[8]

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[6] *See, e.g.,* Patent Trolls: Fact or Fiction: Hearing Before the Subcomm. on Courts, the Internet, and Intell. Prop. of the H. Comm. on the Judiciary, 109th Cong. 17 (2006) [hereinafter Kamen Testimony] (statement of Dean Kamen, President, Deka Research & Development Corp.), available at http://commdocs.house.gov/committees/judiciary/hju28201.000/hju28201_0.HTM (debating whether patent trolls even exist); Mark A. Lemley & Carl Shapiro, *Patent Holdup and Royalty Stacking,* 85 **Tex. L. Rev.** 1991, __ (2007) (asserting that non-practicing entities account for 30-40% of suits in the computer and electronics industries); Jennifer Kahulelio Gregory, *The Troll Next Door*, 6 **J. Marshall Rev. Intell. Prop. L.** 292 (2007); Marc Morgan, *Stop Looking Under the Bridge for Imaginary Creatures: A Comment Examining Who Really Deserves the Title 'Patent Troll'*, 17 **Fed. Cir. B.J.** 165 (2007).

[7] http://lexmachina.stanford.edu

[8] When we speak of value, we refer to *private* value, or value to the owner. We also refer only to the fact of value and not to any quantitative measure of value. We defend the litigation-value connection extensively in our prior work. John R. Allison et al., *Valuable Patents*, 92 **Geo. L.J.** 435 (2004). And the economic literature supports it. *See, e.g.,* Lanjouw & Schankerman, *Characteristics of Patent Litigation: A Window on Competition*, 32 RAND J. Econ. 129 (2001) [hereinafter Lanjouw & Schankerman, Characteristics of Patent Litigation (finding that litigation correlates with patent value); Lanjouw & Schankerman, *Enforcement, supra*, at 4 ("more valuable patents . . . are much more likely to be involved in suits"); Dietmar Harhoff et al., *Citations, Family Size, Opposition and the Value of Patent Rights*, (working paper 1999) (studying German patents and finding that the most valuable patents are those

and that they are most commonly in the hands of companies other than the ones building new products.

In Part I we describe our study. In Part II we report our results. And In Part III we discuss the implications of our findings.

I. Study Design

Only about 1.5% of all patents are ever litigated in court.[9] The average patent is worth no more than a few thousand dollars;[10] litigated patents are almost by definition extreme outliers,

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that have survived a validity challenge, which in Germany is an administrative opposition procedure); Stuart J.H. Graham et al., *Post-Issue Patent "Quality Control": A Comparative Study of US Patent Re-Examinations and European Patent Oppositions,* NBER Working Paper No. 8807 (2002) (same); Dietmar Harhoff & Markus Reitzig, *Determinants of Opposition Against EPO Patent Grants – The Case of Biotechnology and Pharmaceuticals,* working paper (May 2000). *Cf*. Jean O. Lanjouw & Josh Lerner, *The Enforcement of Intellectual Property Rights: A Survey of the Empirical Literature*, 49/50 ANNALES D'ECONOMIE ET DE STATISTIQUE 223-246 (January/June 1998) (surveying the literature on the issue). This paper both strengthens that conclusion and demonstrates for the first time a strong relationship between the number of times a patent is enforced and the determinants of value. It also allows us to refute a hypothesis that we addressed but could not resolve in our prior work: one that would concede that litigated patents are valuable, but deny that they are the *most* valuable patents. Litigation, on this account, is evidence of weakness in a patent. Perhaps competitors quietly take licenses to the *truly* valuable patents, and the ones they fight about are a sort of "upper-middle class" of potentially valuable but less-than-perfect patents.

[9] *See* Mark A. Lemley, *Rational Ignorance at the Patent Office*, 95 **Nw. U. L. Rev.** 1495 (2001).

[10] *See, e.g.,* Kimberly A. Moore, *Worthless Patents,* 20 **Berkeley Tech. L.J.** 1521 (2005) (documenting the failure of most patentees to pay maintenance fees costing only a few thousand dollars); Jonathan A. Barney, *A Study of Patent Mortality Rates: Using Statistical Survival Analysis to Rate and Value Patent Assets,* 30 AIPLA Q.J. 317, 329 (2002) ("A relatively large number of patents appear to be worth little or nothing while a relatively small number appear to be worth a great deal."); Thomas Ewing, *Book Review,* 43 **Santa Clara L. Rev.** 631 (2003) ("Some of the authors simply recount patent procurement and litigation statistics ad nauseum and do not seem to understand that some patents really do have no value whatsoever since no one would ever practice the disclosed technology, as claimed."); Jean O. Lanjouw et al., *How to Count Patents and Value Intellectual Property*, 46 J. INDUS. ECON. 405 (1998). Maintenance fees are due in increasing amounts at periods 3 ½ years, 7 ½ years, and 11 ½ years after the patent issues. 35 U.S.C. § 41(b) (West Supp. 2000). The fees are $830 at 3 ½ years, $1,900 at 7 ½ years, and $2,910 at 11 ½ years. 35 U.S.C. § 41(b). Those fees are halved for small entities. *Id.* .

since the parties are willing to spend millions of dollars per side in legal fees to litigate them.[11] In prior work, two of the authors demonstrated that litigated patents have significantly different characteristics than other patents.[12] They include more claims, cite more prior art, are cited more often by later patents, file more continuation applications, and come from larger "families" of patents.[13] They are also concentrated in some industries, not others; semiconductor patents are particularly unlikely to be litigated.[14] Many of these characteristics are within the control of the patent applicant, and most are known by the time the patent issues. Allison et al. suggest that these characteristics are evidence of the private value of patents.

That prior work depended significantly on a randomly selected sample of cases actually litigated. The development of the Stanford IP Litigation Clearinghouse in December 2008 opens up a second alternative. The Clearinghouse collects every patent infringement lawsuit filed since January 1, 2000 in searchable format, and links those suits to the patents in suit.[15] Using that database, we identified every patent that has been litigated eight or more times between

[11] Am. Intell. Prop. L. Ass'n, **Report of the Economic Survey 2007** (median cost of high-stakes patent lawsuits is $5 million per side in legal fees through trial).

[12] John R. Allison et al., *Valuable Patents*, 92 **Geo. L.J.** 435 (2004); see also John R. Allison & Thomas W. Sager, *Valuable Patents Redux: On the Enduring Merit of Using Patent Characteristics to Identify Valuable Patents*, 85 **Tex. L. Rev.** 1769 (2007) (defending the statistical power of the results in the earlier study).

[13] Allison et al., *supra* note __, at __.

[14] *Id*. at __.

[15] Due to increased availability over time of electronic filings in federal court, the ability to identify patents in suit improves markedly later in time, particularly from 2003 onwards. Moreover, electronic access also varies by district, potentially making this patent data set under-inclusive for certain districts despite hand collection of cases from those districts. Nevertheless, the patents identified represents the best, most representative such data set available.

2000 and 2007 (including cases still pending). We identified 106 such patents.[16] For purposes of our study, we also identified a randomly-selected control set of 106 patents that have been litigated only once during this time period. This allows us to extend the work Allison et al. did in 2004, comparing the "ordinary" litigated patents (already outliers, as we have seen) to the most-litigated patents. If Allison et al. are right, we would expect those most-litigated patents to exhibit even more evidence of private value, and perhaps even more of an industry skew.

To test these hypotheses, we collected a variety of data about both the patents and the patent lawsuits.[17] For each litigated patent, we collected information about small entity status (is the patent owner at issue an individual, university, or small business, as opposed to a large business), whether the patent is assigned before litigation, the number of continuation applications filed leading to issuance of the patent, the raw and adjusted number of "forward citations" (citations to the patent by later patents), the number of "prior art references" the patent makes to U.S. patents, foreign patents, and non-patent prior art, and the number of claims in each patent.

[16] For purposes of this analysis we include declaratory judgment actions as well as actions filed by the patent owner; until 2007 the rules for declaratory judgment required a clear threat of suit by the patent owner. Teva Pharm. USA, Inc. v. Pfizer, Inc., 395 F.3d 1324, 1333 (2005), *abrogated by* MedImmune, Inc. v. Genentech, Inc., 549 U.S. 118 (2007). We count only separate lawsuits; many patent lawsuits are filed against multiple defendants in a single proceeding.

[17] We do not address the outcomes of those lawsuits in this paper; that is the subject of a companion piece. *See* John R. Allison, Mark A. Lemley & Joshua Walker, *Repeat Play, Outcomes, and Settlements in Patent Litigation* (vaporware 2009).

We also categorize each patent into both an industry and a technology in order to ascertain whether significant differences existed in the technology and industry areas.[18] In our description of technology and industry areas for inventions that we actually encountered in our data sets, we attempted to define the areas in a comprehensive way, and our definitions thus are broad enough to include specific inventions not actually found in our data sets.[19]

Technology areas

(1) Software: An invention in which data processing is a sufficiently critical element that at least one claim element in the patent consists of data processing—the actual manipulation of data—regardless of whether the code carrying out that data processing is on a magnetic storage

[18] We did not attempt to create a comprehensive typology of such areas, but for obvious reasons only identified and defined those technology and industry areas we actually encountered in the population of 106 most-asserted patents and the sample of 106 once-litigated patents. Although the size of our data sets is sufficient for sound statistical analysis, the relatively small numbers of observations necessarily results in our having encountered fewer technology and industry areas that we would have been encountered in a much larger patent data set. The technology categories are not necessarily mutually exclusive, because modern inventions so often involve multiple technologies.

Our industry categories are also not all mutually exclusive, reflecting the reality of modern industry crossovers. For example, a software-implemented telecommunications process or product rightly belongs in both a computer and a communications industry category. There are, however, fewer inventions belonging in more than one *industry* category than there are inventions belonging in more than one *technology* area because mixes of technologies in inventions are more common than industry crossovers.

[19] Although we report descriptive statistics and bivariate comparisons for all of our technology and industry areas, we defined a few technology and industry areas encountered in the data set that we ultimately did not subject to statistical testing because the number of observations for such areas was so small as to render statistical analysis meaningless. We did this to create definitions of categories that could also be used in data sets other than the ones we used in this study.

medium or embedded in a chip. The later is often called "firmware."[20] This category includes the two software patent subsets described below.

(2) Pure software: An invention consisting only of data processing—all claim elements in the patent consist of data processing. However, we do include within this definition a patent on data processing in which there is a trivial non-data processing element such as a generic input, output, or storage element clearly not intended to represent any novel technical advance. This category is a subset of Software.

(3) Software business method: Also a subset of software patent, this category includes software patents that cover methods for conducting business transactions. Business method patents are notoriously difficult to define, with possible definitions varying greatly in scope. For this study, we used a narrow definition limited to those patents the claims of which obviously covered only such things as automated generation of customer proposals, advertising, the use of online catalogs, and so on.

(4) Mechanical: A process, machine, or product that consists solely of the use of mechanical parts, sometimes combined with heat, hydraulics, pneumatics, or other power sources; or an invention in which the above is a critical part. Some inventions classified as mechanical also will be in one or more other classifications, such as electronics. While many different types of inventions fit into this category, it is not a catchall "other" category.

[20] The difficulty in defining a software patent, and the detailed reasoning that supports our definition, can be found at Arti K. Rai, John R. Allison, & Bhaven N. Sampat, *University Software Ownership and Litigation: A First Examination*, 87 N.C.L.R. ***, at ms. pp. 14-32 (forthcoming 2009).

(5) Electronics: A process, machine, or product in which the invention or a critical thereof makes use of traditional electronic circuitry or involves electric energy storage. An invention in this classification may also be included in other classifications, including chemistry, mechanics, or optics.

(6) Optics (other than imaging): A process, machine, or product in which the invention or a critical thereof employs light waves. Optics technology sometimes will also be classified in one or more other areas, such as electronics or chemistry.

(7) Imaging: A process, machine, or product in which the invention or a critical part thereof involves the creation and/or processing of images for various purposes. The imaging may be analog or digital. The majority of imaging patents have medical uses, but some serve other purposes such as security or meteorology.

(8) Biotechnology: A process involving advanced genetic techniques intended to construct new microbial, plant, or animal strains, a product created from such a process, or the way such a process or product is used in biotechnology research. Although there are a number of different genetic engineering techniques, for several reasons we decided to not disaggregate these techniques into separate technology areas.

(9) Chemistry: A process consisting of chemical reactions, a product resulting from such a process, an invention of which a chemical process or product is a critical part, or an invention consisting of a purportedly novel use of chemical substances. Closely related inventions such as those on novel metal alloys and non-metallic amalgams are also included. An invention in the

field of chemistry may be included in one or more other classifications, such as electronics or optics.

Industry Areas

(1) Computer: Includes both software and computer hardware inventions, including not only hardware products but also machines and processes for making computer hardware. As discussed below, some inventions in the semiconductor industry are also included in the computer industry category, but not all of them.

(2) Semiconductor: The semiconductor industry category includes inventions of any kind intended to advance the state of the art in researching, designing, or fabricating semiconductor chips. Despite the fact that many semiconductor devices are intended to be computer components, not all are so intended, and we thus do not automatically include semiconductor industry patents in the computer industry category. There are situations in which a patent appropriately belongs in both the computer and semiconductor industry categories, such as a patent on a software or computer hardware invention specifically for use in semiconductor device fabrication, but this is not an automatic industry crossover.

(3) Electronics: This is a somewhat narrower version of the electronics *technology* category. This industry category does include many patents that involve the use of electronics technology, but inventions of which electronics technology forms a part are not always legitimately viewed as being within the electronics *industry*. An example might be an electro-mechanical process (mechanical and electronics technology areas) for creating a packaging

system for integrated circuits and printed circuit boards.[21] Although reasonable minds could differ, it seems most logical to include such an invention in the computer and semiconductor industries for which the packaging is intended, and not in the electrical industry.

(4) Medical: This industry category includes inventions of any kind used for research on, or for the diagnosis or treatment of diseases or other abnormal conditions in humans or animals. Patents on processes and products for *pharmaceutical* purposes are not included in the medical industry category.

(5) Pharmaceutical: The pharmaceutical industry category includes patents on drugs for treating diseases or other abnormal conditions in humans or animals, and processes for producing or using such drugs.

(6) Biotechnology: In this instance, we concluded that the biotechnology *technology* area, defined broadly as we do, should also be as an *industry* category.

(7) Chemical: The chemical industry category includes inventions of all kinds that primarily deal with the making, transportation, and use of chemical substances, *except for pharmaceutical drugs*. It is both narrower and broader than the chemistry *technology* area. It is narrower in the sense that it does not include patents on inventions using chemical techniques to produce non-chemical products that more logically belong in another industry. For example, a patent including an element covering the use of chemical techniques in semiconductor fabrication

[21] *See* U.S. Pat. No. 5,551,216 (filed July 20, 1995).

would not be included in the chemical industry category. The industry category is broader than the chemistry *technology* category by including inventions not employing chemistry techniques but that nevertheless are intended for use by chemical companies, such as a mechanical invention relating to the handling of chemicals.

(8) Communications: The communications industry category includes patents on inventions of all kinds intended to advance the state of the art in communications.

(9) Transportation: This category includes patents on any type of invention related to vehicles of any type, or to the provision of transportation services.

(10) Energy and utility services: This category includes patents on inventions of any kind associated with power generation, transportation, or consumption. Also included are inventions related to the delivery of public utility services.

(11) Financial: This category includes processes and products associated with providing financial services of various kinds. Such patents usually employ software and, if so, are also included in the computer industry category.

(12) Consumer goods and services: This category includes patents on products and services of all kinds intended for personal consumer purposes. Also included are patents on methods for marketing, buying, or delivering personal consumer goods or services, which often will be software-implemented and thus will also fall within the *computer* industry category.

(13) Construction: The communications industry category includes inventions of all kinds related to the erection or maintenance of structures, or to excavation.

Finally, we investigate the nature of the patent plaintiff. Following Lemley and Myhrvold,[22] we categorized each patent owner into one of twelve different "entity status" categories listed in Table 1.

[22] Mark A. Lemley & Nathan Myhrvold, *The Complex Ecology of Patent Plaintiffs* (working paper 2009).

Table 1 **NPE Classes**
NPE Class 1 (Acquired patents)
NPE Class 2 (University heritage or tie)
NPE Class 3 (Failed startup)
NPE Class 4 (Corporate heritage)
NPE Class 5 (Individual inventor started company)
NPE Class 6 (University/govt/NGO)
NPE Class 7 (Startup, pre-product)
NPE Class 8 (Product company)
NPE Class 9 (Individual)
NPE Class 10 (Undetermined)
NPE Class 11 (Industry consortium)
NPE Class 12 (IP subsidiary of product company)

Of the twelve classes of entity, only one (class 8) involves enforcement by a patent owner that actually makes products. The remainder are different types of "non-practicing entities,"[23] sometimes called "patent trolls" for the prototypical practice of hiding under a bridge they did not build and demanding a toll from surprised passers-by. Rather than take a position on what if any non-practicing entities should be considered "trolls," we classify each patent owner and let the reader decide. We do, however, report the results for practicing vs. non-practicing entities (that is, class 8 vs. other classes) as well as the results for each class.

We test each of the results we report in this paper for statistical significance. We report the results in the tables in most cases, or sometimes in the margins, along with each result. But unless otherwise noted, the reader should assume that we report only results with a confidence level greater than 99% (i.e., a p-value of < 0.01).[24]

In addition to descriptive statistics and bivariate comparisons of individual variables between the two datasets,[25] we also checked our results using logistic regression to determine which differences between the two datasets remained significant after accounting for interactions (correlations) among the variables within each set. Logistic regression is one form of multiple regression, which is used when there are multiple predictor (or explanatory) variables and only one dependent variable (here, either a multiply- or singly-litigated patent).

[23] For a few patent owners we could not identify their entity status after a diligent search. We have classed those entities as 10 (Undetermined), and have excluded them from our entity status analyses.
[24] In social science research, a confidence level of 95%, a p-value of 0.05, is typically treated as sufficient to show statistical significance. Thus, a confidence level of 99%, a p-value of 0.01, shows a far greater degree of confidence that differences are not due to random chance.
[25] We adjusted many of the individual variables to normalize skewed distributions before making bivariate statistical comparisons.

We conducted two logistic regressions, one including the key patent characteristics and *technology* areas, the other including those same patent characteristics and *industry* areas.

The patent characteristics included in each regression, some of which are obviously categorical variables and some of which are obviously continuous variables, were: (1) whether ownership of the patent had been assigned after issuance and before the first litigation of that patent; (2) whether the patent was initially issued to a small or large entity; (3) number of U.S. nonprovisional applications leading to the particular patent; (4) number of forward citations adjusted for patent age; (5) number of claims; (6) number of references to prior U.S. patents; (7) number of references to prior foreign patents: and (8) number of reference to nonpatent prior art ("other publications").

In the regression with technology areas, we included all of those listed in the descriptive and bivariate statistics, except that we used the total number of software patents and did not break the software category into subsets. In the regression with industry areas, we included all of those listed in the descriptive and bivariate statistics.

II. Results

A. The Characteristics of the Most Litigated Patents

We begin by investigating the characteristics of the most litigated patents and comparing them to the control set of once-litigated patents. The results are dramatic. The most-litigated patents differ fundamentally in virtually every respect from even the once-litigated patents. We report the results in Tables 2 and 3.

Table 2 shows that the most-litigated patents made extraordinary use of patent continuations. Litigated patents in the control set had an average of two priority applications – the original application and one continuation or divisional. And fully half of the patents in the control set filed no continuation applications at all.[26] By contrast, the most-litigated patents had an average of 4.3 applications each, and the median patent in this set had three applications.

[26] This explains the otherwise odd result that the median number of applications filed is 1.5 – exactly half of the patents had one application, and half had more than one.

Table 2 **Continuation Applications and Forward Citations**	Number of Non-Provisional U.S. Apps.in Chain	Total Number of Forward Citations	Adjusted Total Number of Forward Citations	Total Number of Self-Citations	Adjusted Number of Self-Citations
Most-Litigated Patents					
Mean	4.32075	32.25472	-0.33198	1.27358	2.240506
Median	3	15.5	-0.16507	0	0
Standard Deviation	4.84925	42.41632	1.018704	5.29426	11.19944
Once-Litigated Patents					
Mean	2.00943	14.06604	-0.77296	1.33019	1
Median	1.5	6	-0.13566	0	0
Standard Deviation	1.40404	23.18015	1.743923	2.73503	1.709091
Bivariate Comparison (one sample t test w/ log transformation)					
p-value	0.0001	0.0001	0.0001	0.0173	0.0001
significant?	sig	sig	sig	sig	sig

Table 2 also shows differences in forward citations, which economists have often identified as a measure of patent value.[27] The results here are more complicated. As Hall, Jaffe & Trajtenberg have shown, just counting forward citations can be misleading, because the older a patent is

[27] A number of studies have used forward citations as evidence of patent value. *See, e.g.,* Bronwyn H. Hall, Adam Jaffe, & Manuel Trajtenberg, *Market Value and Patent Citations: A First Look*, NBER working paper No. W7741, at 14 (2001); Dietmar Harhoff et al., *Citation Frequency and the Value of Patented Inventions*, 81 REV. ECON. & STAT. 511 (1999); Manuel Trajtenberg, *A Penny for Your Quotes: Patent Citations and the Value of Innovations*, 21 RAND J. ECON. 172 (1990). *Cf.* Lanjouw & Schankerman, *Characteristics, supra* note __, at 130 (finding that citations received predicted litigation when those citations were made by competitors);

the more time others will have had to cite it.[28] The results also need to be adjusted because citation patterns have changed over time. The base results in Table 2 show that the most-litigated patents are cited more than twice as often as the control set patents. After adjusting the number of forward citations received by patents to account for their different ages, the differences between the two data sets are significant to an exceptional degree. [29]

The differences are even more dramatic in when it comes to backward citations and claims. Table 3 presents these results. The most litigated patents more than 50% more claims than the control set, 39.3 on average compared with 24.5 for once-litigated patents. The number of claims is sometimes associated with patent value, though two of the authors have elsewhere noted the complexity of the claim count-value relationship.[30] Much more significant is the

[28] Hall, Jaffe & Trajtenberg, *supra* note __.

[29] The method of adjustment to account for the different ages of patents involves placing each patent in the data set into a cohort of other patents in the data set that were issued during the same year. Thus, each cohort is one year, although cohorts of more than one year could be used if necessary even though that would decrease precision somewhat. The number of forward citations received by each patent is divided by the average number of forward citations received by other patents in the same cohort. This gives us the adjusted number of forward citations for that patent in the data set. The process is repeated for every other patent in the same cohort, and then repeated for each patent in the other year-cohorts. To obtain the adjusted number of forward citations for an entire data set, we then averaged the number of adjusted number of forward citations received by all patents in the set. The method is from Bronwyn H. Hall, Adam Jaffe, & Manuel Trajtenberg, *The NBER Patent-Citations Data file: Lessons, Insights, and Methodological Tools*, *in* ADAM B. JAFFE & MANUEL TRAJTENBERG, PATENTS, CITATIONS, & INNOVATIONS: A WINDOW ON THE KNOWLEDGE ECONOMY, at 403, 434-37 (2002).

Because of the unusual skew in forward citations, the means for untransformed forward citations look nearly identical even though the differences in the distributions are both dramatic and highly significant. As a result, we also report in Table 2 the log-transformed value for adjusted forward citations, which makes the differences quite clear.

[30] Allison et al., *supra* note __, at __ fn. __. For further discussion of claims and patent value, *see, e.g.,* Lanjouw & Schankerman, *Characteristics of Patent Litigation*, *supra* note __, at 140-42.; John R. Allison & Emerson Tiller, *The Business Method Patent Myth*, 18 **Berkeley Tech. L.J.** 987 (2003) (reviewing the literature on numbers of claims as an indicator of patent value); Kimberly A. Moore, *Xenophobia in American Courts*, 97 **Nw. U. L. Rev.** 1497 (2003) ("The theory that the number of patent claims in a granted patent correlates to patent breadth makes little intuitive or logical sense, however."). cf. John R. Allison & Mark A. Lemley, *The Growing Complexity of the U.S. Patent System*, 82 **B.U. L. Rev.** 77, 104

difference in prior art citations.[31] The most-litigated patents cite nearly three times as many U.S. and foreign patents as other litigated patents, and nearly *ten* times as many non-patent prior art references as other litigated patents. This is particularly notable given that litigated patents themselves cite much more prior art than unlitigated patents.[32] All these differences are significant at extraordinarily high confidence levels.

(2002) (the number of claims can reflect "resource constraints, drafting style, uncertainty about the law or the significance of an invention, or a host of other factors that are not necessarily driven by patent value

[31] Allison et al., *supra* note __, at __ (finding a statistically significant relationship between backward citations and litigation); Allison & Tiller, *Business Method Patent Myth*, *supra* note 30, at __ (arguing that there is a correlation between the number of prior art references and patent value); Harhoff et al, *Citations, Family Size*, *supra* note __ (finding a relationship between prior art references cited and other measures of patent value). *But see* Lanjouw & Schankerman, *Characteristics of Patent Litigation, supra* note 43, at 138 (failing to find a statistically significant relationship between citations to US *patent* prior art references and patent litigation). The theory behind the relationship of backward citations and value is that the more citations that are considered during prosecution by the examiner, the less likely it is that some prior art exists that will invalidate the patent. The more prior art considered, in other words, the more likely a patent is to survive subsequent litigation. *See, e.g.,* Moore, *Xenophobia supra* note __**Error! Bookmark not defined.**, at __ (arguing that "patents that include more citations or more diverse citations are more likely to be valid"); John R. Allison & Mark A. Lemley, *Empirical Evidence on the Validity of Litigated Patents*, 26 **AIPLA Q.J.** 185, __ (1998) (showing that courts rarely invalidate patents on the basis of prior art that was cited to the PTO). Because lawyers know this, the value relationship may reflect not only the strength of patents that cite a lot of prior art, but also efforts by applicants to "bulletproof" patents they expect to litigate by citing a great deal of art.

[32] Allison et al., *supra* note __, at __. Because many of the patents in this sample issued before Jan. 1, 2001, when the PTO began identifying examiner-added prior art on the face of the patent, we were unable to determine whether it was the applicant or the examiner that provided most of this art. However, other work has shown that virtually all non-patent prior art (over 90%) is provided by applicants, not examiners. Mark A. Lemley & Bhaven Sampat, *Examiner Characteristics and the Patent Grant Rate* (working paper 2009) (under submission, **Rev. Econ. & Stat.**). Thus, it is quite likely given the disparity in non-patent prior art citations that the difference is a result of applicant submissions, not examiner diligence.

Table 3 **Number of Claims and References**	Number of Claims	Number of References to US Patents	Number of References to Foreign Patents	Number of Nonpatent References (Printed Publications)
Most-Litigated Patents				
Mean	39.2925	61.462264	9	52.67924528
Median	22.5	12	1	4
Standard Deviation	44.6934	109.30562	18.611824	110.7090178
Once-Litigated Patents				
Mean	24.4623	23.132075	3.5943396	5.613207547
Median	19	12.5	0	0
Standard Deviation	23.6229	30.791797	7.698829	16.20615448
Bivariate Comparison (one sample t test w/ log transformation)				
p-value	0.0002	0.0149	0.0052	1.33E-10
significant?	sig	sig	sig	sig

B. The Technologies and Industries of the Most-Litigated Patents

We also find dramatic differences between most-litigated and once-litigated patents when it comes to the technologies they employ and the industries with which they are associated. Prior work has found that significant numbers of patents issue in a wide variety of technology areas and industries, including mechanics, biotechnology, semiconductors and computer-

related inventions,[33] though the diversity of technologies is a relatively recent phenomenon.[34] In our 2004 study, we found that patents were disproportionately more likely to be litigated in some industries than others, and that semiconductor patents in particular were unlikely to be litigated

We find even more significant differences in technology and industry areas between most-litigated and once-litigated patents. We report two sets of results – one by industry and one by technology. As noted above, the two frequently diverge – a software invention may be used in any number of industries, some traditionally considered computer-related but others entirely divorced from it, such as automobiles or bioinformatics.[35] The results, reported as proportions of the 106 patents in each data set involving the identified technology or industry area, are presented in Tables 4 and 5 and Figures 1 and 2.

[33] *See, e.g.,* John R. Allison & Mark A. Lemley, *Who's PatentingWhat? An Empirical Exploration of Patent Prosecution*, 53 **Vand. L. Rev.** 2099, __ (2000).

[34] *See, e.g.,*Allison & Lemley, *Growing Complexity, supra* note __, at __.

[35] A reminder – inventions can involve more than one industry or technology class, so the proportions exceed 100%. We simply compared proportions between the most-litigated and once-litigated data sets.

Figure 1

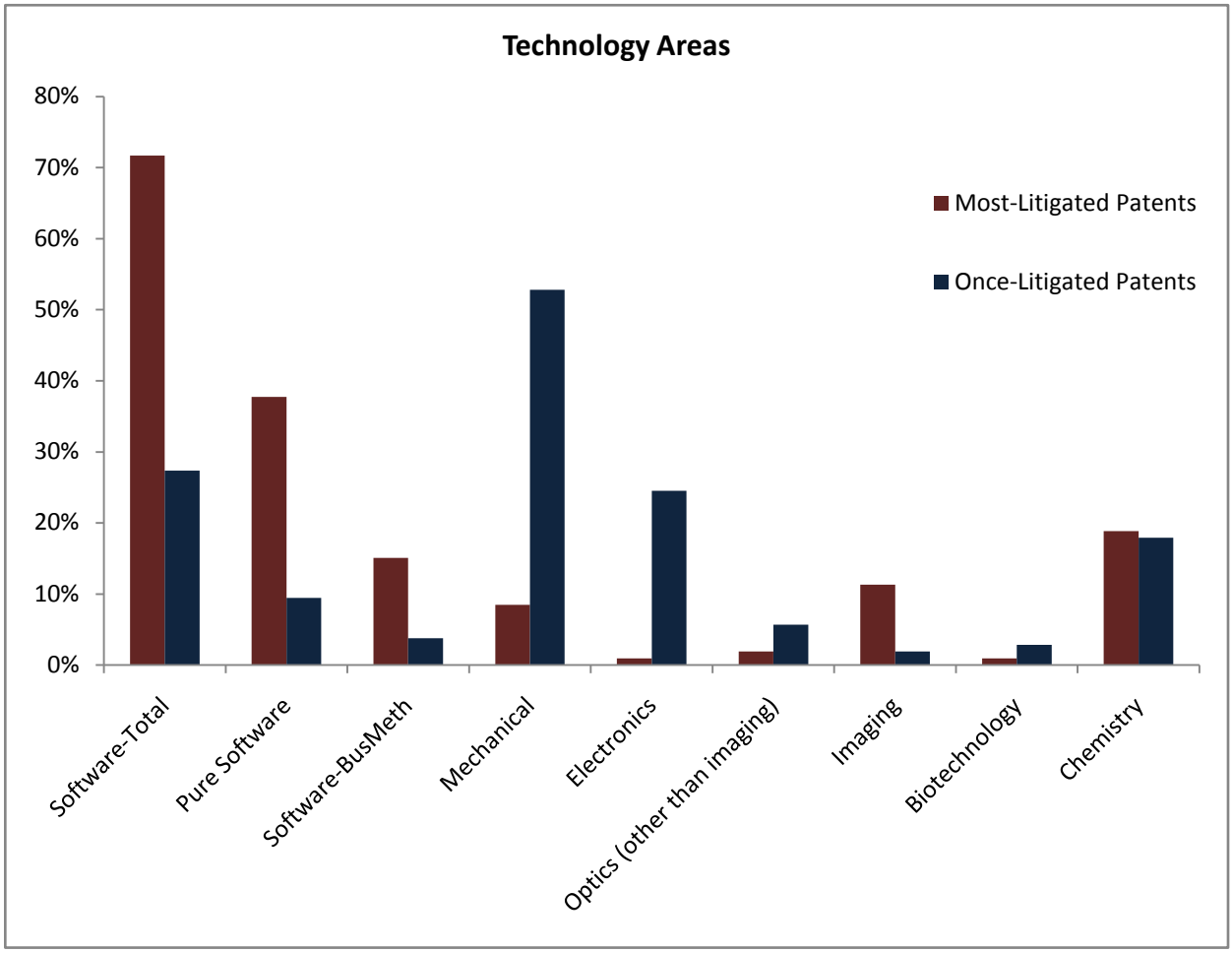

Technology Areas
80%
70%
60%
50%
40%
30%
20%
10%
0%
Most-Litigated Patents
Once-Litigated Patents
Software-Total
Pure Software
Software-BusMeth
Mechanical
Electronics
Optics (other than imaging)
Imaging
Biotechnology
Chemistry

Table 4 Technology Areas Descriptive Statistics	Software-Total	Pure Software	Software BusMeth	Mechanical	Electronics	Optics (other than imaging)	Imaging	Biotechnology	Chemistry
Most-Litigated Patents	0.716981132	0.377358	0.150943	0.084906	0.009434	0.018868	0.113208	0.009434	0.188679
Once-Litigated Patents	0.273584906	0.09434	0.037736	0.528302	0.245283	0.056604	0.018868	0.028302	0.179245
Bivariate Comparison (one sample t test w/ log transformation)									
p-value	1.07341E-10	1.21E-06	0.004809	2.54E-12	2.6E-07	0.149394	0.005684	0.312702	0.859304
significant?	sig	sig	sig	sig	sig	nonsig	sig	nonsig	nonsig

The most-litigated patents are overwhelmingly likely to be software patents. Nearly three-fourths of the most-litigated patents are software patents, compared with just over a quarter of the once-litigated patents. Similarly, software-implemented business method patents are overrepresented in the most-litigated patents group (15% vs. 4%). And imaging patents are much more heavily represented in the most-litigated category (11% vs. 2%) as well. By contrast, mechanical and electronics patents make up the bulk of the once litigated patent cases, but they are only of minor significance in the most-litigated patent set. Mechanical inventions make up only 8% of the most-litigated patents, but 53% of the once-litigated patents; electronics inventions make up only 1% of the most-litigated patents but fully 25% of the once-litigated patents. Other industries, notably biotechnology and chemistry, do not show significant differences between the two data sets.

We see similar variance when we move from the technologies to the industries in which they operate. Table 5 presents the results by industry. The computer industry is once again dominant in the most-litigated patents set; 72% of most-litigated patents are in the computer industry, compared with 34% of the once-litigated patents. Telecommunications is similar; 34% of the most-litigated patents are in the communications industry, compared with 8% of once-litigated patents. By contrast, a variety of more traditional industries, including electronics, medical, chemical, energy, consumer goods and services, and construction are all significantly more likely to show up in the once-litigated patent set than in the most-litigated set.

Figure 2

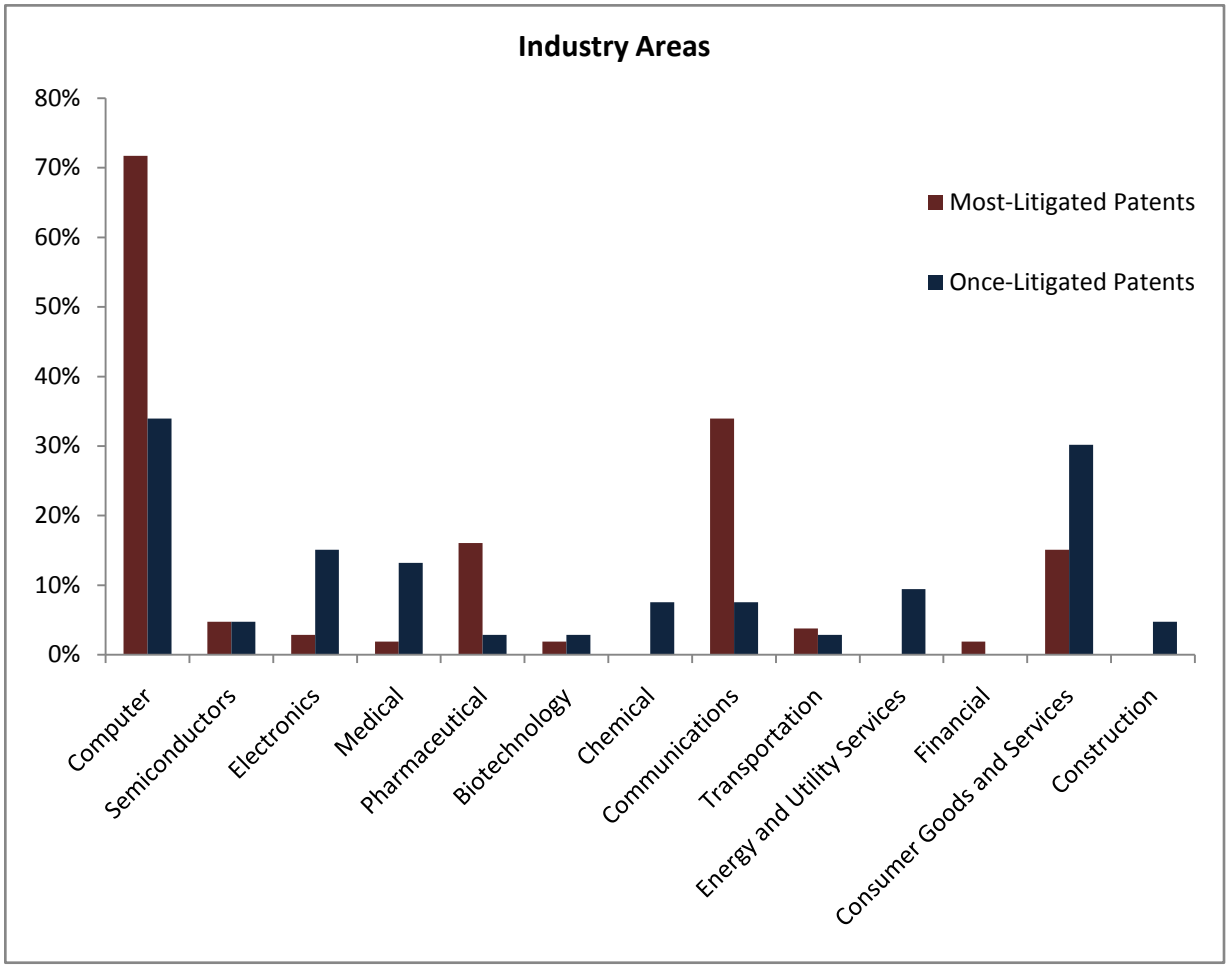

Industry Areas
80%
70%
60%
50%
40%
30%
20%
10%
0%
Most-Litigated Patents
Once-Litigated Patents
Computer
Semiconductors
Electronics
Medical
Pharmaceutical
Biotechnology
Chemical
Communications
Transportation
Energy and Utility Services
Financial
Consumer Goods and Services
Construction

Table 5A

Industry Area	Computer	Semiconductors	Electronics	Medical	Pharmaceutical	Biotechnology	Chemical
Most-Litigated Patents	0.716981	0.04717	0.028302	0.018868	0.160377	0.018868	0
Once-Litigated Patents	0.339623	0.04717	0.150943	0.132075	0.028302	0.028302	0.075472
Bivariate Comparison (one sample t test w/ log transformation)							
p-value	3.73E-08	1	0.001773	0.001808	0.001004	0.650849	0.003935
significant?	sig	nonsig	sig	sig	sig	nonsig	sig

Table 5B

Industry Area	Communications	Transportation	Energy and Utility Services	Financial	Consumer Goods and Services	Construction
Most-Litigated Patents	0.339623	0.037736	0	0.018868	0.150943	0
Once-Litigated Patents	0.075472	0.028302	0.09434	0	0.301887	0.04717
Bivariate Comparison (one sample t test w/ log transformation)						
p-value	2.12E-06	0.700709	0.001197	0.155337	0.008647	0.023641
significant?	sig	nonsig	sig	nonsig	sig	sig

In short, the most-litigated patents are disproportionately information technology (IT) patents – software, business methods (all of which are software-implemented, often employing the Internet), computer industry, and telecommunications. Notably absent from this list is semiconductors; consistent with what Allison et al. found in 2004, semiconductor inventions are a relatively minor percentage of both data sets.

C. The Owners of the Most-Litigated Patents

Finally, we collect a variety of information regarding the owners of the patents in both the most-litigated and the once-litigated sets. To begin, we must separate the initial owner of the patent from the owner when the lawsuit is filed, because one of our findings is that more than a third of all the cases across both data sets were sold to another owner after issue and before the lawsuit was filed.[36]

Small entities start out owning more once-litigated than most-litigated patents: 57 of 106 once-litigated patents were originally assigned to small entities, compared to 40 of the most-litigated patents. While one might conclude that small entities are more likely to be occasional users of the patent system, two problems complicate this. First, a large number of the most-litigated patents are owned by a single entity – Ronald S. Katz Technology Licensing LLP.[37]

[36] 44 of 106 most-litigated patents and 31 of 106 once-litigated patents were sold before litigation. The difference was not statistically significant, however, so we rely only on the aggregate numbers.

[37] Katz had 20 of the top 106 most-litigated patents issued in his name. In fact, however, his impact on the most litigated patents is greater still, because at litigation he owned still other patents that were not assigned to him at issue.

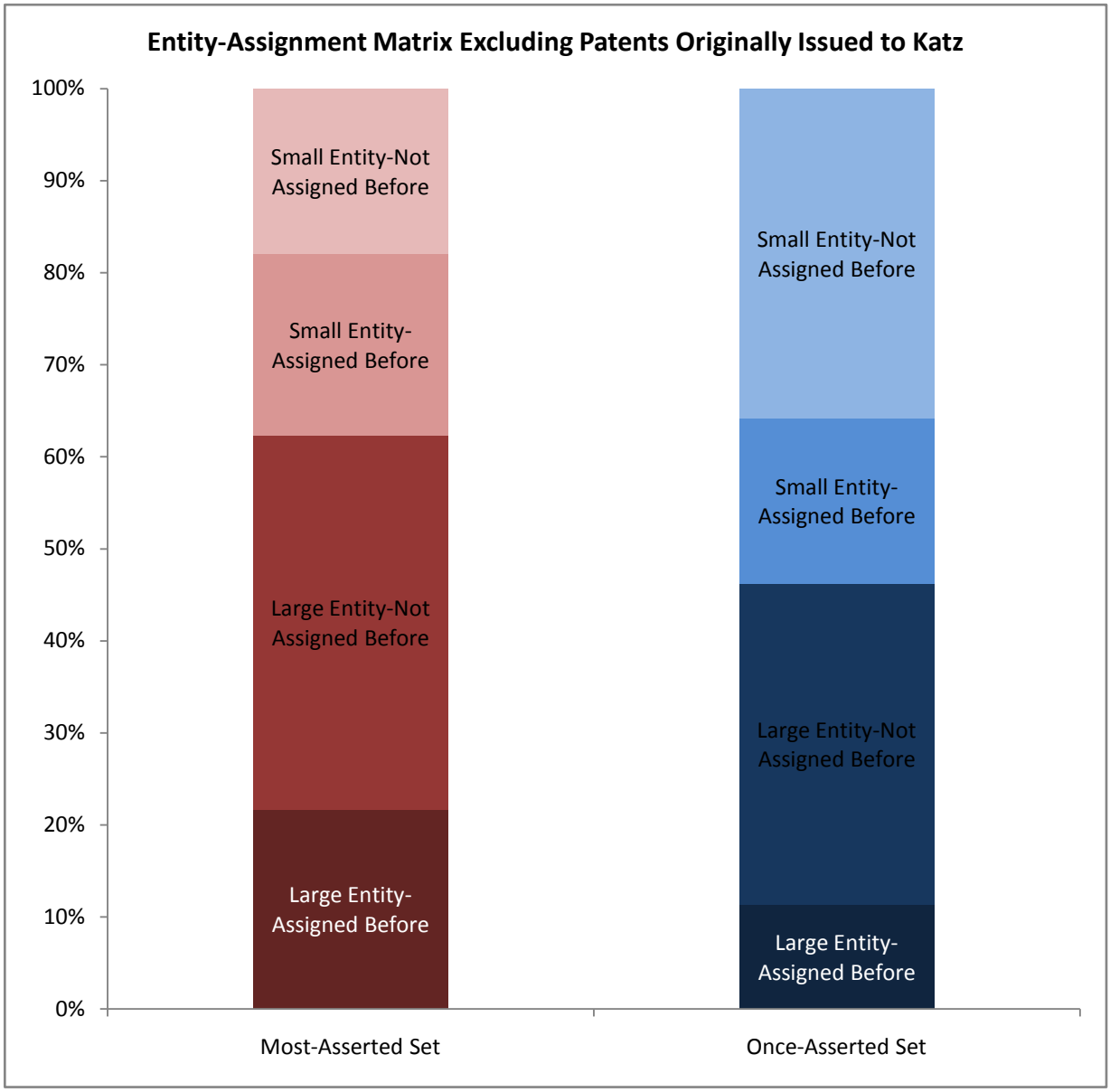
While that company is most probably a "small entity," defined as a company employing fewer than 500 people, the patents were not filed with small entity status. To avoid skewing the data in either direction by treating Katz patents either as large or small entity patents, we have excluded them from the small entity analysis entirely. That means that the small entity numbers are a larger share of the most-litigated patents than the raw numbers suggest. Small entities owned 53.8% of the once-litigated patents and 46.5% of the most-litigated patents.

That is not the end of the story, however, because the owner of the patent at issue is not always the owner of the patent when the suit is filed. Indeed, we find that 44 of 106 most-litigated patents and 31 of 106 once-litigated patents are assigned to another entity before the first lawsuit is filed.[38] In Table 6 and Figure 3, we relate the entity size at issue to the likelihood of assignment before litigation.

[38] This is consistent with Judge Kimberly Moore's finding that assignments of litigated patents are quite common. Kimberly A. Moore, *Populism and Patents*, 82 **N.Y.U. L. Rev.** 69, 92-94 (2007) (noting high level of assignments before litigation, despite the fact that individuals fare better than corporations in patent litigation).

Table 6 **Entity-Assignment Matrix Excluding Patents Originally Issued to Katz**	Large Entity Owner at Issue	Small Entity Owner at Issue		Large Entity Owner at Issue	Small Entity Owner at Issue
Assigned Before Litigation	23	21	Assigned Before Litigation	12	19
Not Assigned Before Litigation	43	19	Not Assigned Before Litigation	37	38

Figure 3



Notably, once assignments are taken into account, it does seem to be the case that small entities that keep their patents rather than selling them tend to litigate less often than either large entities or purchasers of small entity patents. The fact that assigned patents are more

likely to be the most-litigated patents is also consistent with the idea that the most-litigated patents are also the most valuable, since they are more likely to have been sold.[39]

Next, we evaluate the nature of the patent owners in both sets. One of the biggest policy debates in patent reform has been over the nature and extent of "patent trolls." As noted in Part I, we divide the patent plaintiffs in our data sets into twelve different categories. We present the results of that categorization in Table 7 and Figure 4.

[39] An alternative explanation, however, is that once a company pays money to buy a patent it is more likely to enforce that patent, since it wants a return on its investment. Similarly, the correlation between value and assignment may reflect the nature of the acquiring entities, at least for a given subset of cases. An entity purchasing third party patents to assert will presumably do precisely that. Lastly, at least some patent holders may create special purpose entities immediately prior to, and for, litigation.

Figure 4

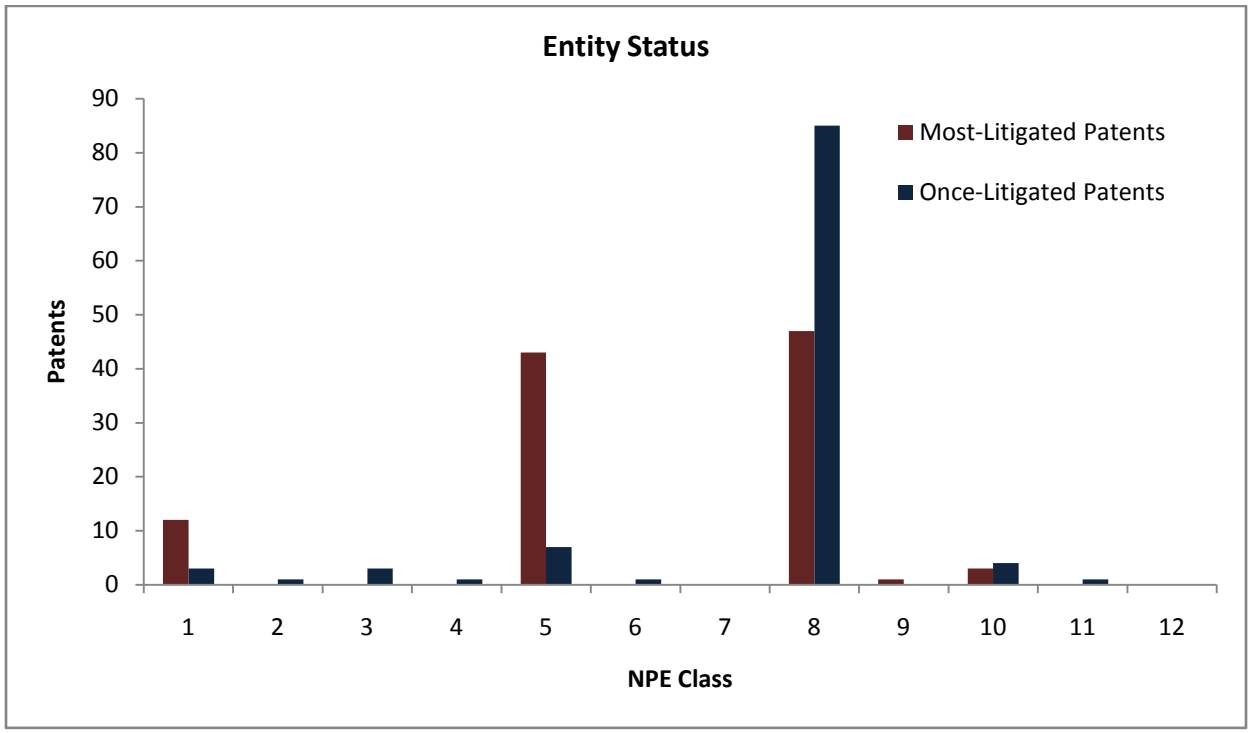

Entity Status
Most-Litigated Patents
Once-Litigated Patents
Patents
90
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
11
12
NPE Class

Table 7 Entity Status		
NPE Classes	**Most Litigated Patents**	**Once Litigated Patents**
NPE Class 1 (Acquired patents)	12	3
NPE Class 2 (University heritage or tie)	0	1
NPE Class 3 (Failed startup)	0	3
NPE Class 4 (Corporate heritage)	0	1
NPE Class 5 (Individual inventor started company)	43	7
NPE Class 6 (University/govt/NGO)	0	1
NPE Class 7 (Startup, pre-product)	0	0
NPE Class 8 (Product company)	47	85
NPE Class 9 (Individual)	1	0
NPE Class 10 (Undetermined)	3	4
NPE Class 11 (Industry consortium)	0	1
NPE Class 12 (IP subsidiary of product company)	0	0
	106	**106**

The differences are dramatic. Once the few entities whose status we could not determine (3 of the most-litigated patents and 4 of the once-litigated patents) are excluded, traditional product companies – those who are participants in the market in which they are enforcing the patent – represent 83.3% of the once-litigated patents but only 45.6% of the most-litigated patents. If one views all non-practicing entities as patent trolls, a view with which we do not necessarily agree,[40] trolls hold a significant share of the most important patents, but are a much smaller

[40] *See* Mark A. Lemley, *Are Universities Patent Trolls?*, 18 **Fordham Intell. Prop., Media & Ent. L.J.** 611 (2008) (no).

share of "ordinary" (once) litigated patents.[41] Notably, though, because the most-litigated patents by definition involve many more lawsuits than the once-litigated patent set, these patents are important to the patent system out of proportion to their numbers. Nonetheless, it is worth keeping in mind that the 2,987 infringement suits filed on the 106 most litigated patents still represent only about 14% of the patent suits filed from 2000 through 2007.[42]

Not surprisingly, we also find significantly more non-practicing entities among the most-litigated patents. Notably, however, non-practicing entities in the most-litigated patent set fall almost entirely into only two classes: licensing companies who are in the business of buying up and enforcing patents ("trolls" by virtually anyone's definition) and companies started by the inventor but which do not make products. Licensing companies account for 11.7% of the most-litigated patent suits, and inventor companies account for 41.7% of those suits. Only one patentee in this group falls into any other category – an individual litigant. By contrast, the ecology of once-litigated patents is somewhat more diverse; that data set includes suits by universities, by university spin-outs, by failed start-ups, by companies that once sold products but no longer do, and by industry consortia. None represents a large percentage of the set of once-litigated patents.

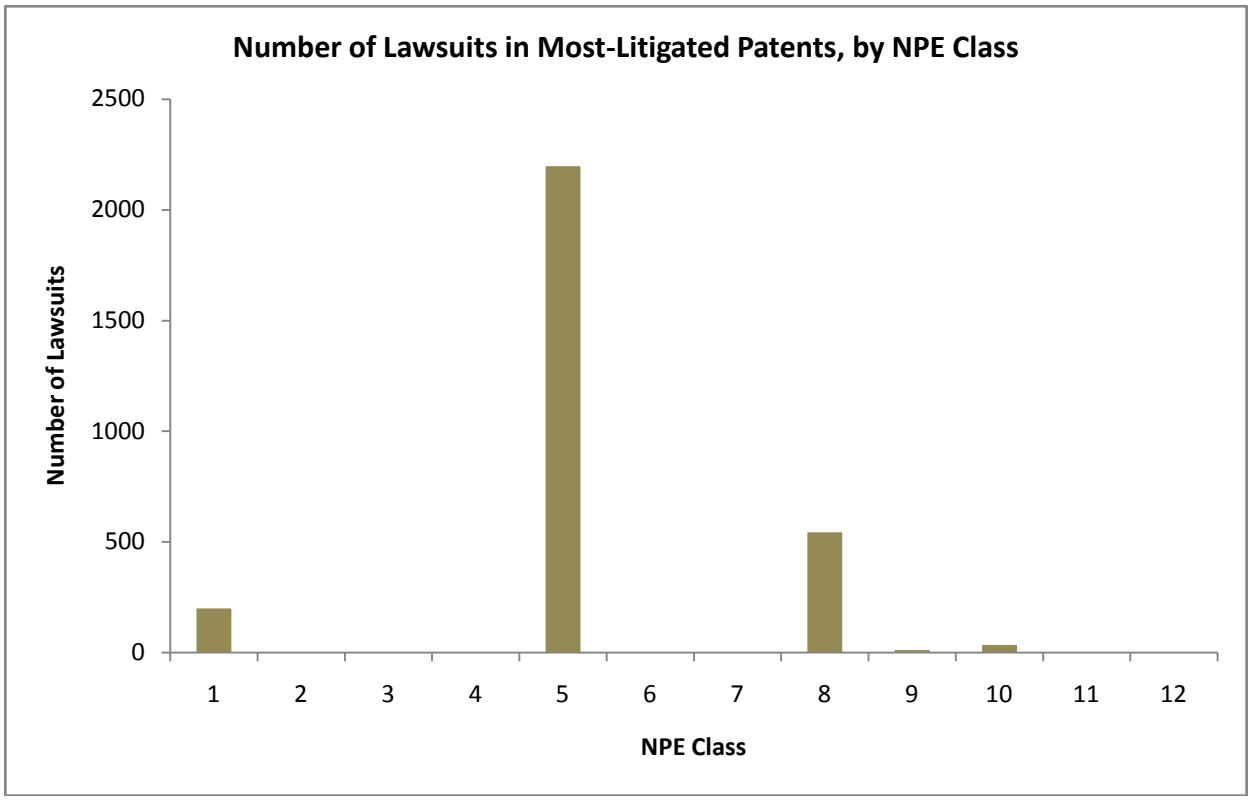
In fact, however, the disparity is even greater than this data suggests. While each patent in the control set has been litigated only once, meaning that each patent has an equal effect on

[41] The differences we report are statistically significant at a 95% or greater confidence level for classes 1, 5, and 8, and at a 99% confidence level for classes 5 and 8.

[42] *See* http://lexmachina.stanford.edu (13,793 total patent suits filed between 2003 and 2007 inclusive). A list of the most litigated patents and the number of suits in the database is attached as Appendix A.

the overall distribution. By contrast, the "most-litigated" patents include some patents litigated 8 times and others litigated 97 times.[43] Weighting NPE status by the number of lawsuits gives us a somewhat different story, one depicted in Table 8 and Figure 5.

Figure 5



[43] *See* Appendix A.

Table 8 Most Litigated Patents by Status		
NPE Classes	Most Litigated Patents	Number of Suits in Most-Litigated Patents
NPE Class 1 (Acquired patents)	11	199
NPE Class 2 (University heritage or tie)	0	0
NPE Class 3 (Failed startup)	0	0
NPE Class 4 (Corporate heritage)	0	0
NPE Class 5 (Individual inventor started company)	41	2198
NPE Class 6 (University/govt/NGO)	0	0
NPE Class 7 (Startup, pre-product)	0	0
NPE Class 8 (Product company)	51	544
NPE Class 9 (Individual)	0	11
NPE Class 10 (Undetermined)	3	35
NPE Class 11 (Industry consortium)	0	0
NPE Class 12 (IP subsidiary of product company)	0	0
	106	**2987**

Once we take account of the number of suits, the share of suits by product companies falls to 18.4%; more than 80% of the most litigated patent suits are filed by NPEs. Overwhelmingly these are filed by inventor-owned or inventor-developed companies; those companies account for 74.4% of the most-litigated patent lawsuits. The share of suits filed by licensing shops actually falls to 6.7% of all suits. Non-practicing entities are a small share of once-litigated patents, but they represent an overwhelming share of the suits filed on the most-litigated patents.

D. Logistic Regression

In both the technology and industry area regressions, we found three continuous variables to be significant or highly significant despite the existence of substantial correlations among many variables: (1) number of U.S. nonprovisional applications leading to the particular patent;[44] (2) number of references to prior U.S. patents;[45] and (3) number of references to nonpatent prior art ("printed publications").[46] In the technology area logistic regression, we found a high degree of significance for the *software* ($p = 0.0024$) and *mechanical* ($p = 0.0004$) areas. In the industry area logistic regression, we found exceptionally high levels of significance for the *computer* ($p < 0.0001$) and *pharmaceutical* ($p < 0.0001$) areas.[47]

Given the unavoidable number of correlated variables in patent data, it is quite meaningful that we found significance in the three continuous variables in both regressions. The more interactions there are among variables, the more difficult it is to tease out predictive power in a multiple regression.[48]

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[44] Tech area regression $p = 0.0303$; industry area regression $p = 0.0359$.

[45] Tech area regression $p = 0.0223$; industry area regression $p = 0.0061$.

[46] Tech area regression $p = 0.0282$; industry area regression $p = 0.0062$.

[47] We report the full results in Appendix B.

[48] Many patent characteristics are necessarily correlated rather highly, such as the numbers of claims, various types of prior art references, number of U.S. applications leading to a particular patent, number of forward citations, and others. The reason is the existence of a common cause: applicants for certain patents perceive in advance that the patent likely will have value to them, that it will be important, and even that it is more likely to be litigated, and this perception often leads them to invest more in making a patent stronger and broader by investing in drafting more claims, finding and citing more prior art, and actively enforcing the patent. Their actions, in turn, tend to create private value for the patent. Applicants do not have the degree of control over the number of forward citations as they do other patent metrics, except for self-citations in their own later patents (which itself is an additional indicator of value because it often shows that they are building a portfolio of patents on closely related inventions, in which the value of the whole can be greater than the sum of its parts). However, these

In addition to the unavoidable correlations among many patent characteristics, the very nature of the question we are asking places some limitations on the logistic regressions. First, the nature of our inquiry into most-litigated patents necessarily means that we have a relatively small number of observations. Data sets of 106 observations each are certainly large enough for statistical analysis, but when combined with the fact of unavoidable interactions among many variables, it would be much better if the data sets were larger. With larger numbers of observations, we would almost certainly find significance with more variables in the regressions. There is, however, no way to make them larger. We are intentionally looking at "upper-outlier patents." Moreover, when we divide the patents in our data sets into technology and industry areas, we necessarily reduce the number of observations even further. This fact makes it even more remarkable that significance in the regressions was found in two technology areas and two industry areas.

Finally, the number of interactions among variables was increased by the fact that, as in our previous studies, we did not treat technology or industry areas as necessarily being mutually exclusive. This reflects patent reality. This is just what modern inventions are like, and an attempt to assign many patented inventions to a single technology or industry area is completely unrealistic and unjustifiable. However, the fact that a single patent may justifiably belong in more than one technology or industry area does further increase the number of interactions among these variables.

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are patents that the owners are more likely to assert through litigation or licensing, and they get more attention, leading to more forward citations by others in later patents. As a consequence, the number of forward citations is also correlated with the internal patent characteristics noted above.

In the end, because of the very nature of the questions we ask and unavoidable interactions in our data, our results may be portrayed less accurately by the logistic regressions than by the descriptive statistics and bivariate comparisons. We have accordingly emphasized those conclusions in the section that follows.

III. Implications

In this section, we draw a number of possible implications from this data. Notably, there are different ways to understand our data, and, depending on one's predisposition, the data might point to different policy conclusions. We seek to identify some of the most likely implications in this section.

A. Extreme Value?

The first thing that stands out is the powerful evidence that the most-litigated patents have different, clearly identifiable characteristics that distinguish them from once-litigated patents (and distinguish them even more dramatically from ordinary, unlitigated patents). Notably, the characteristics that distinguish the most-litigated patents from other patents are also the ones that researchers have long used to identify the most valuable patents: more claims, more prior art citations, more forward citations, more assignments between issue and litigation, and larger numbers of continuing applications. A reasonable conclusion, therefore, is that the most litigated patents are also the most valuable patents. Allison et al drew this conclusion for the general class of litigated patents (patents that had been litigated at least once); that conclusion

seems strengthened substantially by our data.[49] While one might question whether litigation was in fact an indicator of value in all cases, the fact that more litigation is more strongly correlated with the indicia of value suggests that the intuitive relationship between value and litigation is in fact the right one.[50]

The fact that the most-litigated patents are disproportionately owned by non-practicing entities, coupled with our suggestion that the most-litigated patents are the most valuable ones, might lead one to the conclude that non-practicing entities produce the most important patents, and therefore are owed rather more respect than the current patent system (and certainly patent reformers) give them. It might also support a subsidiary conclusion that continuation applications are necessary to support the most important patents.[51] We acknowledge that these are possible implications of our results. But there are reasons to be cautious in drawing that conclusion. The value we identify in this paper is not social value, but private value. Our results suggest that having more claims, more prior art citations, and more continuation applications lead to stronger patents, and a first order assessment might suggest that stronger patents are good. But that doesn't mean that those patents are necessarily better for society or even are valid. It may simply mean that those patents are optimized for

[49] Allison & Lemley, *supra* note __, at __.

[50] This is not to suggest, however, that the objective measures of value accurately capture all or even most of the value of patents; they are necessarily imperfect indicators of that value. David E. Adelman & Katherine L. DeAngelis, *Patent Metrics: The Mismeasure of Innovation in the Biotech Patent Debate*, 85 **Tex. L. Rev.** 1677 (2007). But the fact that they are not perfect predictors doesn't mean there is not an important relationship there. Allison & Sager, *supra* note __.

[51] *Contra* Mark A. Lemley & Kimberly A. Moore, *Ending Abuse of Patent Continuations*, 84 **B.U. L. Rev.** 63 (2004) (arguing that continuations are mostly unnecessary and do more harm than good).

litigation, because they are better protected against the vagaries of claim construction[52] and against validity challenges based on uncited prior art.[53] And because of the well-known constraints under which the PTO operates, it may even be that the PTO is less good at assessing these larger, more complex patents in the limited time examiners can devote to those patents.[54]

Whether the most-litigated patents represent the most important inventions, or just the most valuable rights to exclude, the fact that the patents that are likely to generate the most litigation have identifiable characteristics known before or during patent prosecution has important implications for reforming the patent prosecution process. One of us argued in 2001 that it would not be cost-effective for the PTO to achieve 100% accuracy in granting or denying every patent.[55] Nonetheless, it would surely be desirable to improve the accuracy of PTO decisions in both directions if it could be done without substantial additional expense.[56] And if

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[52] *See, e.g.* ,Dan L. Burk & Mark A. Lemley, *Fence Posts or Sign Posts? Rethinking Patent Claim Construction*, __ **U. Pa. L. Rev.** __ (forthcoming 2009). Burk and Lemley argue that modern claim construction can systematically disadvantage patentees, since even one error in claim drafting or losing one claim construction fight may mean either invalidity or noninfringement. Drafting more claims hedges against this risk by giving the patentee multiple shots at an error-free claim. Continuations also hedge against this risk by allowing patentees to rewrite their claims after the fact.

[53] *See* John R. Allison & Mark A. Lemley, *Empirical Evidence on the Validity of Litigated Patents*, 26 **AIPLA Q.J.** 185, __ (1998) (finding that it is much harder to invalidate patents based on art cited before the patent office, leading to the possibility of "bulletproofing" a patent application by including as much prior art as possible). Relatedly, a sea of citations may actually *diminish* the PTO's ability to analyze invalidity with respect to the most salient prior art included therein, since examiners operate under severe time constraints and are not given more time to examine applications just because they include more prior art.

[54] We endeavor to test this in a companion paper that investigates the outcomes of the most litigated patent cases. Allison, Lemley, & Walker, *supra* note __, at __.

[55] Lemley, *Rational Ignorance, supra* note __, at __.

[56] *See, e.g.,* Joseph Farrell & Robert P. Merges, *Incentives to Challenge and Defend Patents: Why Litigation Won't Reliably Fix Patent Office Errors and Why Administrative Patent Review Might Help*, 19

we have good information on which patents are likely to turn out to be important, at least in the sense that their validity is going to matter, we can use that information to focus more attention on those applications during the prosecution process. Patent reformers have, for example, proposed post-grant opposition,[57] a tiered review or "gold-plating" system,[58] and outside peer review of patents.[59] Each of those proposals, to be workable, requires the selection of certain patents or applications on which to focus additional attention. The value data may give us a means to select applications for additional review. It could also be systematized within the PTO, for example by replacing the "one-size-fits-all" allocation of examiner time with a complexity weighting system that gave examiners more time and more credit for evaluating the most complex (and most valuable) applications. Moreover, the ability to identify the patents most valuable patents in advance may allow companies to focus their attention on smaller sets of patents to be concerned about when they invent in the same or a related area. It may also provide investors with more relevant information when deciding

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Berkeley Tech. L.J. 943 (2004); Joseph Farrell & Carl Shapiro, *How Strong Are Weak Patents?*, 98 **Am. Econ. Rev.** __ (2008).

[57] *See, e.g.,* Mark D. Janis, *Rethinking Reexamination: Toward a Viable Administrative Revocation System for U.S. Patent Law*, 11 HARV. J.L. & TECH. 1 (1997); Robert P. Merges, *As Many as Six Impossible Patents Before Breakfast: Property Rights for Business Concepts and Patent System Reform*, 14 BERKELEY TECH. L.J. 577 (1999); Craig Allen Nard, *Certainty, Fence Building, and the Useful Arts*, 74 IND. L.J. 759 (1999); J. H. Reichman, *From Free Riders to Fair Followers: Global Competition Under the TRIPS Agreement*, 29 N.Y.U. J. INT'L L. & POL. 11 (1997); John R. Thomas, *Collusion and Collective Action in the Patent System: A Proposal for Patent Bounties*, 2001 U. ILL. L. REV. 305.

[58] Doug Lichtman & Mark A. Lemley, *Rethinking Patent Law's Presumption of Validity*, 60 **Stan. L. Rev.** 45 (2007); Mark A. Lemley, Doug Lichtman & Bhaven Sampat, *What To Do About Bad Patents*, **Regulation**, Winter 2005-06, at 10. While one might view applicant bullet-proofing as a form of "gold plating," the latter term refers to a proposal that the PTO devote additional resources to examine certain applications and award a patent that has correspondingly higher deference.

[59] Beth Simone Noveck, *"Peer to Patent": Collective Intelligence, Open Review, and Patent Reform*, 20 **Harv. J. L. & Tech.** 123 (2006).

whether to help fund a start-up, take a security interest in a patent for a loan, or make some other investment decision.[60]

The data also suggest substantial variation by technology and industry in how patent litigation works. That itself should come as no surprise; Burk and Lemley have documented the many ways in which both patent law and innovation incentives are industry-specific, and the Congressional debates over patent reform have pitted different industries against each other on issue after issue.[61] But the disproportionate representation of software, telecommunications, and business method patents among the most litigated patents might suggest that it is appropriate to pay more attention to patents in those technologies and industries, both in court and at the PTO, just as the importance of patents with multiple claims and prior art citations suggests that those patents are more important than the average patent.

B. Trolls on Top?

The other important difference evident from this data is the prevalence of non-practicing entities in the most-litigated patents. Patent reform debates have – perhaps unfortunately – focused a great deal of attention on "patent trolls." There is substantial disagreement as to whether trolls exist and how significant a role they play in patent litigation. Our data sheds significant light on this question, though readers may disagree on how they interpret that data.

Non-practicing entities are clearly an important phenomenon in the modern patent system. While they account for only about 16% of the once-litigated patents, they represent over 80%

[60] *See* Allison & Sager, *supra* note **, at 1787-88.

[61] **Dan L. Burk & Mark A. Lemley, The Patent Crisis and How Courts Can Solve It** (forthcoming 2009).

of the suits filed involving the most-litigated patents, and own more than half of the most-litigated patents themselves. Clearly, then, the role of non-practicing entities in the modern patent system cannot be dismissed and should not be diminished.[62]

Whether this represents a flood of patent trolls depends critically on how one defines the term patent troll. If a patent troll is anyone who sues to enforce a patent they do not practice, trolls are indeed rampant among the most litigated patents. But if we limit the definition to companies enforcing patents that cover inventions they did not themselves develop, the number of patent trolls drops dramatically, to 12% of the patents and 7% of the lawsuits. And even if the reader decides that trolls are rampant, that fact informs policy debates over patent reform but does not itself tell us whether to celebrate or deplore the role of patent trolls.

Lemley has argued that we should not focus so much attention on labeling particular plaintiffs as trolls or not, but instead on making sure that the patent rules provide patentees of all types fair compensation but not opportunities for holdup.[63] Even if we are not to create troll-specific rules, however, our findings here are important because they suggest that the remedy rules that do depend on the plaintiff's status, such as entitlement to injunctive relief[64] and lost profits damages,[65] are critically important and need to be evaluated in the context of a world in

[62] Nathan Myhrvold and Mark Lemley assess the role of non-practicing entities in a separate paper. Myhrvold & Lemley, *supra* note __, at __. That paper is more limited than this one because it focuses on the telecommunications, computer, and electronics industries, but is also broader because unlike this one it covers all suits in those industries.

[63] Lemley, *supra* note __, at __.

[64] eBay, Inc. v. MercExchange LLC, 126 S.Ct. 1837 (2006).

[65] *See, e.g.,* BIC Leisure Prods. v. Windsurfing Int'l, 1 F.3d 1214 (Fed. Cir. 1993) (reversing an award of lost profits because the patentee and the infringer did not compete); *Cf.* Del Mar Avionics, Inc. v. Quiniton Instrument Co., 836 F.2d 1320 (Fed. Cir. 1987) (describing it as a "general rule" that patentees

Appendix A
The Most-Litigated Patents[66]

which the most significant patent lawsuits are not those filed by competitors against competitors.

producing the patented item are entitled to lost profits damages); John E. Dubiansky, *An Analysis for the Valuation of Venture Capital-Funded Startup Firm Patents,* 12 **B.U. J. Sci. & Tech. L.** 170, 177 (2006) ("In the licensing context, however, the patent owner is not engaged in an enterprise which utilizes the patent. Consequentially, the owner has no profits to have lost, and is only eligible to receive a reasonable royalty.").

Patent Number	Assignee/Applicant Name	Earliest Case Title	Plaintiff	NPE Class ID
5132992	YURT PAUL|BROWNE H LEE	Acacia Media Tech Co v. New Destiny Internet	Acacia Media Tech Co	1
6144702	Greenwich Information Technologies, LLC	Acacia Media Tech Co v. New Destiny Internet	Acacia Media Tech Co	1
5734961	Genese	Antor Media Corp v. Audiogalaxy Inc, et al	Antor Media Corp	10
4924257	JAIN; KANTILAL	Anvik Corporation v. Nikon Precision, Inc. et al	Anvik Corporation	8
5285236	JAIN; KANTI	Anvik Corporation v. Nikon Precision, Inc. et al	Anvik Corporation	8
5291240	Anvik Corporation	Anvik Corporation v. Nikon Precision, Inc. et al	Anvik Corporation	8
5721606	JAIN; KANTI	Anvik Corporation v. Nikon Precision, Inc. et al	Anvik Corporation	8
5897986	Anvik Corporation	Anvik Corporation v. Nikon Precision, Inc. et al	Anvik Corporation	8
6748318	ArrivalStar, Inc.	Arrival Star, Inc. v. Nistevo Corporation	Arrival Star, Inc	1
6904359	ArrivalStar, Inc.	Arrival Star, Inc. v. Pilot Air Freight Corp.	Arrival Star, Inc	1
5738872	Hoechst Marion Roussel, Inc.	AVENTIS PHARMACEUTIC, et al v. BARR LABORATORIES	AVENTIS PHARMACEUTIC	8
5855912	Hoechst Marion Roussel, Inc.	AVENTIS PHARMACEUTIC, et al v. BARR LABORATORIES	AVENTIS PHARMACEUTIC	8
6037353	Hoechst Marion Roussel, Inc.	AVENTIS PHARMACEUTIC, et al v. BARR LABORATORIES	AVENTIS PHARMACEUTIC	8
6113942	Aventis Pharmaceuticals Inc.	AVENTIS PHARMACEUTIC, et al v. BARR LABORATORIES	AVENTIS PHARMACEUTIC	8
6187791	Merrell Pharmaceuticals Inc.	AVENTIS PHARMACEUTIC, et al v. BARR LABORATORIES	AVENTIS PHARMACEUTIC	8
6399632	Merrell Pharmaceuticals Inc.	AVENTIS PHARMACEUTIC, et al v. BARR LABORATORIES	AVENTIS PHARMACEUTIC	8
6482516	Banner Pharmacaps, Inc.	BANNER PHARMACAPS IN v. PERRIGO COMPANY, et al	BANNER PHARMACAPS IN	8
6044362	NEELY; R. ALAN	BCE EMERGIS TECH. v. EDOCS, INC.	BCE EMERGIS TECH.	8
6374229	Billingnetwork.com, Inc.	Billingnetwork.com v. Advanced Healthcare	Billingnetwork.com	8
5951643	NCR Corporation	Boardman Molded Products, Inc. v. Mats, Inc.	Boardman Molded Products, Inc.	8
6151601	NCR Corporation	Boardman Molded Products, Inc. v. Mats, Inc.	Boardman Molded Products, Inc.	8
6169997	NCR Corporation	Boardman Molded Products, Inc. v. Mats, Inc.	Boardman Molded Products, Inc.	8

[66] The count here is based on the number of lawsuits in which the patent could be verified using IPLC data. Because some lawsuits, including some of Katz's lawsuits, involve more than one patent, the actual number of cases filed by the plaintiffs identified here is smaller than simply adding the number of suits for each patent would suggest.

6480855	NCR Corporation	Boardman Molded Products, Inc. v. Mats, Inc.	Boardman Molded Products, Inc.	8
6502096	NCR Corporation	Boardman Molded Products, Inc. v. Mats, Inc.	Boardman Molded Products, Inc.	8
5933630	Acceleration Software International Corporation	Computer Acceleration Corporation v. Microsoft Corporation	Computer Acceleration Corporation	1
5883964	Cygnus Telecommunications Technology LLC	Cygnus Telecom Tech v. International Telec, et al	Cygnus Telecom Tech	1
6035027	Cygnus Telecommunications Technology LLC	Cygnus Telecom Tech v. International Telec, et al	Cygnus Telecom Tech	1
5910988	CSP Holdings, Inc.	Datatreasury Corp v. First Data Corp, et al	Datatreasury Corp	1
6032137	CSP Holdings, LLC	Datatreasury Corp v. First Data Corp, et al	Datatreasury Corp	1
4975950	LENTZ; STEPHEN A.	Digital Development Corporation v. Asus Computer International	Digital Development Corporation	10
5121345	LENTZ; STEPHEN A.	Digital Development Corporation v. Asus Computer International	Digital Development Corporation	10
6295530	BRADSHAW JONATHAN M.	East Manufactoring Corp. v. Titan Trailers, Inc., et al	East Manufactoring Corp.	8
6961737	Ablaise Limited	East Manufactoring Corp. v. Titan Trailers, Inc., et al	East Manufactoring Corp.	8
7075673	EON-Net L.P.	Eon-Net LP v. Flagstar Bancorp	Eon-Net LP	5
6683697	Millenium L.P.	Eon-Net, L.P. v. Black Hound New York	Eon-Net, L.P.	5
5313229	GILLIGAN FEDERICO G|FALCON FERNANDO D	F & G Research, Inc. v. Kye International	F & G Research, Inc.	5
4787722	Fresnel Technologies, Inc.	Fresnel Technologies v. Rokonet Industries	Fresnel Technologies	8
RE35534	Fresnel Technologies Inc.	Fresnel Technologies v. Rokonet Industries	Fresnel Technologies	8
6294196	Hoffmann-La Roche Inc.	HOFFMANN-LA ROCHE INC. v. GATE PHARMACEUTICALS et al	HOFFMANN-LA ROCHE INC.	8
6298862	Laughlin Products, Inc.	IN RE LAUGHLIN PRODUCTS, INC., PATENT LITIGATON	LAUGHLIN PRODUCTS, INC.	5
6464703	Elektromedizin GmbH	In re Katz Interactive Call Processing Patent Litigation	Katz	5
4663318	DAVIS; BONNIE	In re: '318 Patent Infringement Litigation	Barr Laboratories	8
5922333	Laughlin Products, Inc.	Laughlin Products In v. TRB Group	Laughlin Products In	5
7040022	Great Neck Saw Manufacturers, Inc.	Laughlin Products, Inc v. Binder et al	Laughlin Products, Inc	5
5425085	Rates Technology Inc.	Laughlin Products, Inc. v. Bariana et al	Laughlin Products, Inc.	5
6474343	Laughlin Products, Inc.	LAUGHLIN PRODUCTS, INC. v. ETS, INC. et al	LAUGHLIN PRODUCTS, INC.	5

5258855	System X, L. P.	Millennium, L.P. v. Hyland Software, Inc.	Millennium, L.P.	5
5369508	System X, L. P.	Millennium, L.P. v. Hyland Software, Inc.	Millennium, L.P.	5
5625465	International Patent Holdings Ltd.	Millennium, L.P. v. Hyland Software, Inc.	Millennium, L.P.	5
5768416	Millennium L.P.	Millennium, L.P. v. Hyland Software, Inc.	Millennium, L.P.	5
6094505	Millennium L.P.	Millennium, L.P. v. Hyland Software, Inc.	Millennium, L.P.	5
RE39247	Monsanto Technology LLC	Monsanto Company et al v. SUGGS	Monsanto Company	8
5352605	Monsanto Company	Monsanto Company v. McFarling	Monsanto Company	8
5699526	NCR Corporation	NCR Corporation v. Microstrategy Inc., et al	NCR Corporation	8
6026403	NCR Corporation	NCR Corporation v. Microstrategy Inc., et al	NCR Corporation	8
5137342	Oakley, Inc.	Oakley Inc v. Pacific Sunwear, et al	Oakley Inc	8
5367627	Clear with Computers, Inc.	Orion IP, LLC v. Staples, Inc	Orion IP, LLC	1
5615342	Clear With Computers, Inc.	Orion IP, LLC v. Staples, Inc	Orion IP, LLC	1
5053407	Daiichi Pharmaceutical Co., Ltd.	Ortho-McNeil Pharm., et al v. Mylan Laboratories, et al	Ortho-McNeil Pharm.	8
5991791	NCR Corporation	Overstock.com v. NCR	Overstock.com	8
6253203	NCR Corporation	Overstock.com v. NCR	Overstock.com	8
6777095	Parker-Hannifin Corporation	Parker-Hannifin Corporation v. Zippertubing (Japan) Ltd.	Parker-Hannifin Corporation	8
5809336	Patriot Scientific Corporation	Patriot Scenitific Corporation v. Sony Corporation Of America	Patriot Scientific Corporation	8
6298341	Raredomains.com, LLC	Rare Domains.com, LLC v. Verio, Inc.	Rare Domains.com, LLC	8
5519769	Rates Technology Inc.	Rates Technology Inc. v. Technology Arts, Inc. et al	Rates Technology Inc.	1
5243627	AT&T Bell Laboratories	Rembrandt Technologies, LP v. Comcast Corporation et al	Rembrandt Technologies, LP	1
6570967	Ronald A. Katz Technology Licensing, L.P.	Ronald A Katz Technology Licensing, LP v. Alltel Corporation et al	Ronald A Katz Technology Licensing, LP	5
5109404	First Data Resources, Inc.	Ronald A. Katz Technology Licensing, L.P. v. Ahold USA Inc. et al	Ronald A. Katz Technology Licensing, L.P.	5
4792968	FDR Interactive Technologies	Ronald A. Katz Technology Licensing, L.P. v. Citibank, N.A. et al	Ronald A. Katz Technology Licensing, L.P.	5
4930150	First Data Resources Inc.	Ronald A. Katz Technology Licensing, L.P. v. Citibank, N.A. et al	Ronald A. Katz Technology Licensing, L.P.	5
5251252	First Data Resources Inc.	Ronald A. Katz Technology Licensing, L.P. v. Citibank,	Ronald A. Katz Technology Licensing,	5

		N.A. et al	L.P.	
5255309	First Data Resources Inc.	Ronald A. Katz Technology Licensing, L.P. v. Citibank, N.A. et al	Ronald A. Katz Technology Licensing, L.P.	5
5259023	First Data Resources Inc.	Ronald A. Katz Technology Licensing, L.P. v. Citibank, N.A. et al	Ronald A. Katz Technology Licensing, L.P.	5
5351285	First Data Resources Inc.	Ronald A. Katz Technology Licensing, L.P. v. Citibank, N.A. et al	Ronald A. Katz Technology Licensing, L.P.	5
5561707	Ronald A. Katz Technology Licensing L.P.	Ronald A. Katz Technology Licensing, L.P. v. Citibank, N.A. et al	Ronald A. Katz Technology Licensing, L.P.	5
5684863	Ronald A. Katz, Technology Lic. L.P.	Ronald A. Katz Technology Licensing, L.P. v. Citibank, N.A. et al	Ronald A. Katz Technology Licensing, L.P.	5
5787156	Ronald A. Katz Technology Licensing, LP	Ronald A. Katz Technology Licensing, L.P. v. Citibank, N.A. et al	Ronald A. Katz Technology Licensing, L.P.	5
5828734	Ronald A. Katz Technology Licensing, LP	Ronald A. Katz Technology Licensing, L.P. v. Citibank, N.A. et al	Ronald A. Katz Technology Licensing, L.P.	5
5835576	Ronald A. Katz Technology Licensing, L.P.	Ronald A. Katz Technology Licensing, L.P. v. Citibank, N.A. et al	Ronald A. Katz Technology Licensing, L.P.	5
5898762	Ronald A. Katz Technology Licensing, L.P.	Ronald A. Katz Technology Licensing, L.P. v. Citibank, N.A. et al	Ronald A. Katz Technology Licensing, L.P.	5
5917893	Ronald A. Katz Technology Licensing, L.P.	Ronald A. Katz Technology Licensing, L.P. v. Citibank, N.A. et al	Ronald A. Katz Technology Licensing, L.P.	5
5974120	Ronald A. Katz Technology Licensing, L.P.	Ronald A. Katz Technology Licensing, L.P. v. Citibank, N.A. et al	Ronald A. Katz Technology Licensing, L.P.	5
6035021	KATZ; RONALD A.	Ronald A. Katz Technology Licensing, L.P. v. Citibank, N.A. et al	Ronald A. Katz Technology Licensing, L.P.	5
6044135	Ronald A. Katz Technology Licensing, L.P.	Ronald A. Katz Technology Licensing, L.P. v. Citibank, N.A. et al	Ronald A. Katz Technology Licensing, L.P.	5
6148065	Ronald A. Katz Technology Licensing, L.P.	Ronald A. Katz Technology Licensing, L.P. v. Citibank, N.A. et al	Ronald A. Katz Technology Licensing, L.P.	5
6292547	Ronald A. Katz Technology Licensing, L.P.	Ronald A. Katz Technology Licensing, L.P. v. Citibank, N.A. et al	Ronald A. Katz Technology Licensing, L.P.	5
6335965	Ronald A. Katz Technology Licensing, L.P.	Ronald A. Katz Technology Licensing, L.P. v. Citibank, N.A. et al	Ronald A. Katz Technology Licensing, L.P.	5
6424703	Ronald A. Katz Technology Licensing, L.P.	Ronald A. Katz Technology Licensing, L.P. v. Citibank, N.A. et al	Ronald A. Katz Technology Licensing, L.P.	5
6434223	Ronald A. Katz Technology Licensing, L.P.	Ronald A. Katz Technology Licensing, L.P. v. Citibank, N.A. et al	Ronald A. Katz Technology Licensing, L.P.	5

6512415	Ronald A. Katz Technology Licensing LP.	Ronald A. Katz Technology Licensing, L.P. v. Citibank, N.A. et al	Ronald A. Katz Technology Licensing, L.P.	5
6678360	Ronald A. Katz Technology Licensing, L.P.	Ronald A. Katz Technology Licensing, L.P. v. Citibank, N.A. et al	Ronald A. Katz Technology Licensing, L.P.	5
5048075	First Data Resources Inc.	Ronald A. Katz Technology Licensing, L.P., v. American Airlines, Inc. et al	Ronald A. Katz Technology Licensing, L.P.,	5
5338874	Tanaka Kikinzoku Kogyo K.K.	SANOFI-AVENTIS U.S. LLC et al v. SANDOZ, INC.	SANOFI-AVENTIS U.S. LLC et al	8
6495721	Teva Pharmaceutical Industries Ltd.	Teva Pharmaceutical Industries Ltd. et al v. Torrent Pharmaceuticals Ltd. et al	Teva Pharmaceutical Industries Ltd. et al	8
6500987	Teva Pharmaceutical Industries Ltd.	Teva Pharmaceutical Industries Ltd. et al v. Torrent Pharmaceuticals Ltd. et al	Teva Pharmaceutical Industries Ltd. et al	8
6600073	Teva Pharmaceutical Industries Ltd.	Teva Pharmaceutical Industries Ltd. et al v. Torrent Pharmaceuticals Ltd. et al	Teva Pharmaceutical Industries Ltd. et al	8
6897340	Teva Pharmaceutical Industries Ltd.	Teva Pharmaceutical Industries Ltd. et al v. Torrent Pharmaceuticals Ltd. et al	Teva Pharmaceutical Industries Ltd. et al	8
4777354	THOMAS; BARRY	Thomas v. Adelphia Communications Corporation et al	Barry Thomas	9
RE35616	Tillotson Corporation	Tillotson Corp v. High Five Products, et al	Tillotson Corp	8
6766304	Trading Technologies International, Inc.	Trading Tech Intl, et al v. eSpeed Inc	Trading Tech Intl, et al	8
6772132	Trading Technologies International, Inc.	Trading Tech Intl, et al v. eSpeed Inc	Trading Tech Intl, et al	8
5091171	YU RUEY J|SCOTT EUGENE J VAN	Tristrata Technology v. Mary Kay Inc.	Tristrata Technology	8
5128984	First Data Resources Inc.	Verizon CA Inc v. Ronald A Katz Tech	Verizon CA Inc	5
5815551	Ronald A. Katz Technology Licensing, LP	Verizon CA Inc v. Ronald A Katz Tech	Verizon CA Inc	5
6349134	Ronald A. Katz Technology Licensing, L.P.	Verizon CA Inc v. Ronald A Katz Tech	Verizon CA Inc	5
6054482	Godecke Aktiengesellschaft	WARNER-LAMBERT COMPA, et al v. PUREPAC PHARMACEUTIC, et al	WARNER-LAMBERT COMPANY	8