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ARTICLES

Our Divided Patent System*

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In this comprehensive new study, we evaluate all substantive decisions rendered by any court in every patent case filed in the years 2008 and 2009—decisions made between 2009 and 2013. We assess the outcome of litigation by technology and industry. We relate the outcomes of those cases to a host of variables, including variables related to the parties, the patents, and the courts in which those cases were litigated.

We find dramatic differences in the outcomes of patent litigation by both technology and industry. For example, owners of patents in the pharmaceutical industry fare much better in dispositive litigation rulings than do owners of patents in the computer and electronics industry, and chemistry patents have much greater success in litigation than their software or biotechnology counterparts. Our results

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provide an important window into both patent litigation and industry-specific battles over patent reform. These results suggest that the traditional narrative of industry-specific patent disputes, which pits the information technology industries against the life sciences, is incomplete.

INTRODUCTION

We nominally have a unitary patent system. With rare exceptions, the patent statutes don't treat different technologies or different industries differently. Indeed, by treaty, patents are to be made available without discrimination by technology.[1]

Despite this unitary nature, different industries have increasingly experienced very different patent systems in practice. Prior evidence suggests that both the process and ease of obtaining patents differ substantially by industry and technology.[2] And a decade of experience with legislative patent

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1 See Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) Art 27(1), 33 ILM 1197, 1208 (1994).

2 See, for example, Mark A. Lemley and Bhaven Sampat, *Is the Patent Office a Rubber Stamp?*, 58 Emory L J 181, 196 (2008) (finding very different grant rates in different technology classes); John R. Allison and Mark A. Lemley, *The Growing*

reform has made it clear that many of the large players in the pharmaceutical and computer industries have diametrically opposed views of whether and how the patent system promotes innovation.[3] The users of the patent system, then, don't seem to view it as unitary.

We offer empirical evidence that is consistent with this sharp division by technology and industry. Building on our comprehensive new study of patent-litigation outcomes,[4] in this Article we examine how our results differ by both technology and industry.

The differences by technology are dramatic. Of the lawsuits that reach a merits decision, patents in the chemical field are found valid and infringed more than half the time, while software patents are found valid and infringed in fewer than one in seven cases. Owners of biotechnology[5] patents fare even worse in litigation than software patent owners, winning only 5.6 percent of the cases that reach a merits ruling. We see a similar result when we sort not by the nature of the patented technology but by the industry of the patent owner, with a similarly sharp divide between the pharmaceutical, computer and electronics, and biotechnology industries.

In Part I, we discuss the prior work on the industry-specific nature of the patent system. In Part II, we explain our data set and methodology. We present our results in Part III and discuss some implications in Part IV.

Complexity of the United States Patent System, 82 BU L Rev 77, 114–25 (2002) (finding that patent applicants in different industries experience very different prosecution processes).

3 See Colleen V. Chien, *Patent Amicus Briefs: What the Courts' Friends Can Teach Us about the Patent System*, 1 UC Irvine L Rev 395, 399 (2011) ("[D]isagreement between the pharmaceutical and high-tech industries has been characterized as making it impossible to enact meaningful congressional patent reform."). See also Brad Stone, *Engineers Fight Patent Reform, Not Patent Trolls* (NY Times, Aug 30, 2007), archived at http://perma.cc/XL5W-G4UA (noting a patent litigator's opinion that patent reform "has pitted two of the leading technology sectors against one another, specifically the computer industry versus pharmaceutical industry").

4 See generally John R. Allison, Mark A. Lemley, and David L. Schwartz, *Understanding the Realities of Modern Patent Litigation*, 92 Tex L Rev 1769 (2014).

5 Here we refer to "biotechnology" *as a technology*. We also use the term "biotechnology" to refer to an *industry*. We later discuss the difference in some detail, and whenever we use the term "biotechnology," we will make our usage of the term clear.

I. Cracks in the Unitary Patent System

Patent law was first enacted in the United States in 1790.[6] Inventions in 1790 tended to be machines or simple mechanical devices. The dominance of machines persisted for most of the country's history. As Robert Merges puts it, a hundred years ago, "if you put technology in a bag and shook it, it would make some noise."[7] As late as the 1970s, the majority of all patents issued in the United States were mechanical inventions.[8]

But the nature of inventions has been changing rapidly. While chemical inventions have been around for some time, in the last forty years software and electronics patents have grown dramatically, to the point that they have eclipsed mechanical inventions and now account for a majority of all patents.[9] That shift is also reflected in patents that reach a final ruling in litigation; as we explain below, roughly half of the lawsuits in our data set involved software or electronics technologies, with chemical and biotechnology patents accounting for another 20 percent of the lawsuits.[10]

The natures of mechanical, software, and chemical inventions differ, and so do their relationships to the patent system.[11] James Bessen and Michael Meurer have gone so far as to argue that the patent system works in the pharmaceutical and chemical industries but serves as a drag on innovation elsewhere.[12] And many have suggested that we should abolish

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6 See Patent Act of 1790, 1 Stat 109.

7 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, 585 (1999) (explaining that at the time of the Founding, "technology" was something readily identifiable).

8 See Allison and Lemley, 82 BU L Rev at 93 (cited in note 2).

9 See Lemley and Sampat, 58 Emory L J at 195 (cited in note 2) (finding that roughly half of the patent applications filed in 2001 were in the information technology industries). See also Allison and Lemley, 82 BU L Rev at 93 (cited in note 2) (finding a dramatic growth in software and other information technology patents between the 1970s and 1990s).

10 See Table 1.

11 For a detailed discussion, see, for example, Dan L. Burk and Mark A. Lemley, *The Patent Crisis and How the Courts Can Solve It* 167–70 (Chicago 2009) (arguing that courts are best suited to deal with tailoring patents to differences across industries); Dan L. Burk and Mark A. Lemley, *Policy Levers in Patent Law*, 89 Va L Rev 1575, 1577 (2003) (arguing that patent law is technology neutral in theory but technology specific in application).

12 See James Bessen and Michael J. Meurer, *Patent Failure: How Judges, Bureaucrats, and Lawyers Put Innovators at Risk* 146 (Princeton 2008). Bessen and Meurer's primary empirical evidence for their claim is based on an event study. Basically, they studied market movements in stock prices of publicly traded companies after the filing of patent infringement lawsuits. Others have criticized their methodology and questioned their findings. See, for example, David L. Schwartz and Jay P. Kesan,

certain types of patents (generally software or business methods) altogether.[13] But others who haven't gone that far nonetheless

Analyzing the Role of Non-practicing Entities in the Patent System, 99 Cornell L Rev 425, 447–48 (2014) (characterizing as "facially implausible" Bessen and Meurer's estimate that each nonpracticing entity lawsuit, on average, caused each defendant to drop in market capitalization between $122 million and $140.6 million); Glynn S. Lunney Jr, *On the Continuing Misuse of Event Studies: The Example of Bessen and Meurer*, 16 J Intel Prop L 35, 37, 49–56 (2008). Another researcher reports data suggesting that stock market losses upon case filings are recovered at case disposition. See Ron D. Katznelson, *Questionable Science Will Misguide Patent Policy* *3–5 (Oct 27, 2013), archived at http://perma.cc/P7TY-AT2J. Despite these concerns, others besides Bessen and Meurer, including one of the authors of this Article, have offered some evidence that patents are more important for innovation in the life science technologies than in technologies like software. See, for example, Burk and Lemley, *The Patent Crisis* at 37–65 (cited in note 11); Mark A. Lemley, *Software Patents and the Return of Functional Claiming*, 2013 Wis L Rev 905, 935 (explaining that in the software industry, innovation is less costly, copyrights prevent copying, and "[n]etwork effects may allow innovators to capture significant returns even absent IP protection").

[13] See, for example, Brian J. Love, *Why Patentable Subject Matter Matters for Software*, 81 Geo Wash L Rev Arguendo 1, 3 (2012) (arguing that while the § 101 exclusion is problematic, it is "virtually the only defensive mechanism left"); Joshua D. Sarnoff, *Patent-Eligible Inventions after* Bilski*: History and Theory*, 63 Hastings L J 53, 118–20 (2011) (arguing that business methods, software, genetic consequences, and medical diagnostics or treatments do not require more patent protection); The League for Programming Freedom, *Software Patents: Is This the Future of Programming?*, 10 Dr Dobb's J 56, 56 (Nov 1990) (alleging that software patents "threaten to devastate America's computer industry" and that the solution is to eliminate software patents); Pamela Samuelson, Benson *Revisited: The Case against Patent Protection for Algorithms and Other Computer Program-Related Inventions*, 39 Emory L J 1025, 1135–36 (1990) (arguing that copyright law is more appropriate for software than patent law is); Allen Newell, *Response: The Models Are Broken, the Models Are Broken!*, 47 U Pitt L Rev 1023, 1025 (1986) ("Any attempt to erect a patent system for algorithms that tries to distinguish algorithms as one sort of thing and mental steps as another, will ultimately end up in a quagmire."). But see Mark A. Lemley, et al, *Life after* Bilski, 63 Stan L Rev 1315, 1326–27 (2011) (arguing that bright-line rules determining what is or is not patentable are inappropriate due to changing technologies and the lack of a clear division between certain types of patents); Michael Risch, *Everything Is Patentable*, 75 Tenn L Rev 591, 622–23 (2008) (arguing that whether an algorithm is patentable should be determined by whether it has practical utility); Robert P. Merges, *Software and Patent Scope: A Report from the Middle Innings*, 85 Tex L Rev 1627, 1656–57 (2007) (noting that patents have not fundamentally harmed the software industry); Donald S. Chisum, *The Patentability of Algorithms*, 47 U Pitt L Rev 959, 1014–15 (1986) (arguing that excluding software patents is inappropriate because "[t]he pattern of production of algorithms and computer programs is the same as the production of other products and services").

In *Bilski v Kappos*, 561 US 593 (2010), four justices would have drawn a similar line banning the patenting of business methods. Id at 614 (Stevens concurring). See also Peter S. Menell, *Forty Years of Wondering in the Wilderness and No Closer to the Promised Land:* Bilski*'s Superficial Textualism and the Missed Opportunity to Return Patent Law to Its Technology Mooring*, 63 Stan L Rev 1289, 1312 (2011) ("Justice Stevens's concurrence provides a persuasive explication. . . . There is no reason to believe that 'business methods' have become a science or technology fitting the functional patent mold during the course of the past two centuries."); John R. Thomas, *The Patenting of the Liberal Professions*, 40 BC L Rev 1139, 1145–47 (1999) (noting the history of disputes over patentable subject recognize that different industries and technologies have different needs and characteristics.[14] The patent system has responded to those differences, not by creating industry- or technology-specific patent statutes, but by varying the application of the unitary patent statute to respond to the characteristics and needs of each industry.[15] A number of scholars have thought about the various ways in which the patent system treats different industries and technologies differently.[16] And

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matter). But see John R. Allison and Starling D. Hunter, *On the Feasibility of Improving Patent Quality One Technology at a Time: The Case of Business Methods*, 21 Berkeley Tech L J 729, 736 (2006) (presenting empirical evidence that, although the Patent and Trademark Office (PTO) had a program to add a second level of review to applications for certain software-implemented business-method patents that seemed to have improved the quality of patents issued after going through the extra examination, the practice of singling out one class of applications or patents for markedly different treatment will ultimately prove to be futile and counterproductive); John R. Allison and Emerson H. Tiller, *The Business Method Patent Myth*, 18 Berkeley Tech L J 987, 1004 (2003) (presenting empirical evidence that software-implemented business-method patents issued through the end of the 1990s were of a quality not inferior to other types of patents).

14 See, for example, Burk and Lemley, *The Patent Crisis* at 37–65 (cited in note 11).

15 See id. See also Dan L. Burk and Mark A. Lemley, *Is Patent Law Technology-Specific?*, 17 Berkeley Tech L J 1155, 1183 (2002) ("District courts have recognized the difference, applying the Federal Circuit rules in different ways depending on the technology at issue.").

16 See, for example, Bessen and Meurer, *Patent Failure* at 146 (cited in note 12); Burk and Lemley, *The Patent Crisis* at 4–5 (cited in note 11); Burk and Lemley, 89 Va L Rev at 1577 (cited in note 11); Burk and Lemley, 17 Berkeley Tech L J at 1183 (cited in note 15); James Bessen and Michael J. Meurer, *Lessons for Patent Policy from Empirical Research on Patent Litigation*, 9 Lewis & Clark L Rev 1, 27 (2005) ("[P]atent policy should be tailored to reflect [ ] industry differences."); Stephen M. Maurer and Suzanne Scotchmer, *Procuring Knowledge*, in Gary D. Libecap, ed, *Intellectual Property and Entrepreneurship* 1, 2 (Elsevier 2004) (arguing that "different models of knowledge creation call for different incentive schemes"); Richard C. Levin, et al, *Appropriating the Returns from Industrial Research and Development*, 1987 Brookings Papers Econ Activity 783, 794–95 (demonstrating the differences in patent effectiveness across industries); Edwin Mansfield, *Patents and Innovation: An Empirical Study*, 32 Mgmt Sci 173, 176–77 (1986) (examining the extent to which various firms and industries rely on the patent system to protect their innovations). See also Michael W. Carroll, *One for All: The Problem of Uniformity Cost in Intellectual Property Law*, 55 Am U L Rev 845, 884 (2006) ("Some analysts . . . have suggested that patent terms should be tailored to vary by industry."); Gideon Parchomovsky and R. Polk Wagner, *Patent Portfolios*, 154 U Pa L Rev 1, 42–43 (2005) (arguing that it is best to hold a diverse portfolio of patents to maximize value); Amir A. Naini, *Convergent Technologies and Divergent Patent Validity Doctrines: Obviousness and Disclosure Analyses in Software and Biotechnology*, 86 J Patent & Trademark Off Socy 541, 567 (2004) ("The Federal Circuit has sought to adapt patent law to the different needs of the biotechnology and software industries by applying its patent validity doctrines in different ways."); Wesley M. Cohen, Richard R. Nelson, and John P. Walsh, *Protecting Their Intellectual Assets: Appropriability Conditions and Why U.S. Manufacturing Firms Patent (or Not)* *23–24 (National Bureau of Economic Research Working Paper Series, Feb 2000), archived at http://perma.cc/2KQ8-XDTW (observing how the uses of patents differ across industries); Mark Schankerman, *How Valuable Is Patent*

there has been some empirical work focused on other questions that touch on industry- or technology-specific differences.[17]

II. Data and Methodology

In this Part, we explain in detail the techniques that we used to locate and collect the data.[18] We describe the data sources and provide information about the coders. We then describe our process of selecting data for inclusion in the data set.[19]

A. Data Collection

Electronic-filing requirements mean that the online-filing tool of the federal courts, Public Access to Court Electronic Records (PACER), has a nearly complete collection of litigation documents from patent cases.[20] Some scholars have taken advantage of PACER data to analyze district court decisions.[21] But the raw data provided by the Administrative Office of the

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Protection? Estimates by Technology Field, 29 RAND J Econ 77, 79 (1998) (summarizing empirical findings that the "distribution of the private value of patent rights is sharply skewed in all technology fields").

17 See, for example, Colleen V. Chien, *Predicting Patent Litigation*, 90 Tex L Rev 283, 294–308 (2011) (discussing the data that influences which patents are litigated); Colleen V. Chien, *Of Trolls, Davids, Goliaths, and Kings: Narratives and Evidence in the Litigation of High-Tech Patents*, 87 NC L Rev 1571, 1600–05 (2009) (presenting data on who brings lawsuits across the various patent industries); John R. Allison, Mark A. Lemley, and Joshua Walker, *Extreme Value or Trolls on Top? The Characteristics of the Most-Litigated Patents*, 158 U Pa L Rev 1, 3 & n 3 (2009) (finding that software and telecommunications patents are litigated far more frequently than mechanical or other types of patents); Jay P. Kesan and Gwendolyn G. Ball, *How Are Patent Cases Resolved? An Empirical Examination of the Adjudication and Settlement of Patent Disputes*, 84 Wash U L Rev 237, 251–54 (2006) (collecting scholarship regarding the factors that determine the length of patent litigation); Paul M. Janicke and LiLan Ren, *Who Wins Patent Infringement Cases?*, 34 AIPLA Q J 1, 19–21 (2006) (describing win-rate variances in patent cases depending on the main technology involved in the case).

18 We plan to release the data set to the public after the completion of our third and final article on this project, which considers entity status (that is, operating companies versus nonpracticing entities).

19 Portions of this Section are adapted from our prior paper to the extent that this paper reflects the same methodology. See generally Allison, Lemley, and Schwartz, 92 Tex L Rev 1769 (cited in note 4).

20 For a discussion of PACER coding and its shortcomings, see generally Matthew Sag, *Empirical Studies of Copyright Litigation: Nature of Suit Coding* (Loyola University Chicago School of Law), archived at http://perma.cc/N8HX-U4G2.

21 See, for example, Kesan and Ball, 84 Wash U L Rev at 261 (cited in note 17) (examining the online docket reports available through the PACER system).

United States Courts is notoriously error prone,[22] and it does a poor job of classifying outcomes.[23]

We used the Lex Machina database as our data source.[24] Lex Machina provides convenient access to cleaned and verified PACER data for district court patent litigation, which permitted us to evaluate all patent lawsuits. The Lex Machina data set offers three primary benefits. First, it includes all lawsuits—even those without a decision available on Westlaw or Lexis—and thus captures some district court decisions that the latter two sources may miss.[25] Second, Lex Machina has cleaned and evaluated the PACER data, eliminating many of the errors in the raw data.[26] Finally, Lex Machina has indexed the cases to identify summary judgment rulings, trial events, and appeals.[27]

Our study covers all patent lawsuits filed in federal district courts between January 1, 2008, and December 31, 2009. We selected the years 2008 and 2009 for several reasons. First, those years are sufficiently recent to provide a snapshot of current patent litigation. Second, because the cases were initiated several years ago, the overwhelming majority of those cases were finally resolved or settled before our project began.[28] Lex Machina graciously provided us with a list of lawsuits from the years 2008 and 2009 that contained at least one ruling on summary judgment or trial. Lex Machina furnished a second list of lawsuits from the same years, including cases with an appeal but without

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22 See id (finding that a substantial percentage of cases were misclassified as patent cases). See also Kimberly A. Moore, *Judges, Juries, and Patent Cases—an Empirical Peek inside the Black Box*, 99 Mich L Rev 365, 381 (2000) (eliminating some cases misclassified as patent trials from the data set).

23 See Kesan and Ball, 84 Wash U L Rev at 265 (cited in note 17) (explaining that the Administrative Office of the United States Courts' categories for case disposition are "rather ambiguous").

24 See *Lex Machina* (Lex Machina, 2015), archived at http://perma.cc/8KFE-CW63.

25 See *Features* (Lex Machina, 2015), archived at http://perma.cc/UNJ6-SE9W ("[V]iew all patent case outcomes for a specific judge or district, displayed in easy-to-read charts and graphs supported by interactive case lists.").

26 See *How It Works* (Lex Machina, 2015), archived at http://perma.cc/75XN-GP4E ("Lex Machina cleans, codes, and tags all data.").

27 See id ("We identify all asserted patents, findings, and outcomes, including any damages awarded. We also build a detailed timeline linking all the briefs, motions, orders, opinions, and other filings for every case.").

28 We conducted the coding in the late summer and fall of 2013. As of February 2014, it appeared that only 2 to 3 percent of cases from the years 2008 and 2009 were still open. See Dennis Crouch, *Pendency of Patent Infringement Litigation* (Patently-O, Feb 17, 2014), archived at http://perma.cc/AV4J-J3LW. See also Kesan and Ball, 84 Wash U L Rev at 246 (cited in note 17) (defending the decision to study cases by year filed rather than by year terminated).

a summary judgment ruling or trial. The second list allowed us to capture cases in which the parties stipulated to judgment based upon a claim-construction decision with the goal of placing the case in condition for appeal. Both lists provided by Lex Machina included basic information about each lawsuit, including the judicial district in which the case was filed, the identity of the district court judge, and the filing date of the lawsuit.

From the cases provided by Lex Machina, we excluded lawsuits that did not include a complaint either alleging infringement of a utility patent or seeking declaratory relief of noninfringement or invalidity of a utility patent. Thus, we excluded inventorship and licensing disputes, malpractice actions, and allegations of design or plant patent infringement. After removing these lawsuits, we reviewed the docket report in detail, reading all relevant orders, opinions, motions, verdicts, appellate rulings, and other necessary court documents to code the litigation outcomes.

Because many of the dockets were extremely complicated—it was not uncommon for a patent case to have over five hundred docket entries—we felt that student coders would be ill-suited to the task. Coding of outcomes, especially in patent cases, is notoriously difficult and time consuming, requiring deep knowledge of patent law and litigation as well as the motivation to devote long hours to the task. Consequently, Mark Lemley and David Schwartz each personally coded the litigation-outcome information for approximately half of the lawsuits. Both Lemley and Schwartz are experienced patent litigators who understand how to read a docket and appreciate complex litigation rulings. The hand coding was extremely time intensive; it took several hundred hours in the aggregate. To permit an evaluation of the reliability and consistency of the coding, Lemley and Schwartz also overlapped in their coding of approximately 10 percent of the lawsuits.[29]

29 Lemley and Schwartz each initially coded approximately 5 percent of the cases. Thereafter, they compared results and fine-tuned the codebook. For coding of the remaining cases, Lemley and Schwartz overlapped in 10 percent of the initial list of cases provided by Lex Machina. Some of the cases provided by Lex Machina turned out not to have relevant merits decisions. After a manual review of the dockets, the 10 percent overlap resulted in thirty patent cases with duplicate coding. To increase the amount of overlap and permit the use of statistical tests to report intercoder reliability, Schwartz additionally coded another random 15 percent overlap with Lemley, for an additional forty-six patent cases with duplicate coding. We chose Cohen's kappa (κ) as the measure of intercoder reliability. See Mark A. Hall and Ronald F. Wright, *Systematic Content Analysis of Judicial Opinions*, 96 Cal L Rev 63, 113–14 (2008) (stating that the best

Our study uses a patent-case combination as the unit of analysis. For each case, we coded the outcome separately for each asserted patent. For instance, if the jury returned a verdict on two patents, we recorded separately what occurred for each patent.[30] For each patent, we also obtained a variety of patent demographic information and various facts about the lawsuit in question. We report those findings in our companion paper, and we detail the information we collected there.[31] We coded each civil action separately.[32] If multiple civil actions involved the same patent, we coded them as separate observations, even if the lawsuits were consolidated. The descriptive statistics that we report below include each patent in each civil action, even those in consolidated lawsuits. However, our regression models take into account consolidated lawsuits, since we clustered on standard errors at both the patent and case level in these models.[33]

For each patent in a lawsuit, the coders reviewed and captured all rulings on summary judgment relating to a patent-law issue. This includes rulings on motions of summary judgment on noninfringement, infringement, validity, invalidity, no inequitable conduct, and inequitable conduct. We excluded

practice for evaluating coding reliability is to report an agreement coefficient, such as κ). κ ranges from 0 to 1, with numbers near 1 indicating a higher degree of reliability. See id (explaining that a 0 indicates "agreement entirely by chance" and that a 1 indicates "perfect agreement"). For the basic definitive and interim winners in cases, κ was 0.9534, equating to near-perfect agreement. For grants of motions for summary judgment on invalidity and noninfringement, κ was 0.9793, which also equates to near-perfect agreement for times in which we both identified motions. However, one of us found one additional motion for summary judgment of invalidity (forty versus thirty-nine). For motions for summary judgment on noninfringement, we each identified motions that the other did not (forty-two motions were found by both authors; one found forty-three motions, while the other identified forty-four motions). We revisited the overlapping case dockets again to understand these additional rulings, and we found that the additionally identified rulings should be included. We corrected all known disagreements in the data set. We believe that these differences in coding are due to the complexity of the dockets, and we do not believe that they are biased in one direction or another. We do believe, however, that the reliability information suggests that we slightly undercounted the number of merits rulings, although we cannot be sure whether the actual number should have more denials or grants.

30 Occasionally, the court ruled differently on different claims of a patent. For instance, a first claim may be infringed and not invalid, while a second claim was not infringed and anticipated. In these cases, we created a new record for each group of claims that had a different substantive outcome, thus taking the unit of observation down from the level of the patent to the level of the individual claim or group of claims.

31 See Allison, Lemley, and Schwartz, 92 Tex L Rev at 1179–80 (cited in note 4).

32 In general, we treated a decision on a patent in a lawsuit as a single observation even if the patent was asserted against multiple parties in the same suit.

33 See note 76.

rulings on issues that were not patent specific, such as laches. We also excluded summary judgment rulings on patent-law issues if the court did not reach the merits of those issues—such as denials of summary judgment motions on the grounds that they were premature. The coders also reviewed and recorded all trial outcomes, whether there was a jury or bench trial, as well as decisions on post-verdict motions for judgment as a matter of law. Finally, we recorded whether an appeal was lodged, and how the appeal was resolved. The resolution data set includes whether the ruling on the patent was affirmed or reversed on appeal, or whether an appeal is pending or was dismissed (typically because the case settled). When the underlying trial or appellate court opinion lacked sufficient detail to ascertain the basis for the ruling, we read the underlying briefing by the parties.

We coded merits decisions at a low level of granularity. For invalidity, we coded whether the ruling was based on utility, patentable subject matter, § 102 prior art,[34] obviousness, indefiniteness, written description, enablement, or best mode. We also coded various bases for § 102 invalidity. For infringement, we captured literal infringement, the doctrine of equivalents, and various types of indirect infringement. We also coded unenforceability, as well as the basis for the unenforceability argument. In addition to the separate coding of issues for summary judgment and trial, we also recorded the final resolution for each patent on the issues of infringement, validity, and enforceability.

Notably, we coded the issues litigated to decision, whether or not that decision resulted in a trial outcome or a grant of summary judgment. Thus, if an accused infringer argued that the patent was invalid for lack of patentable subject matter, anticipation, and obviousness, and the court denied the first two arguments but granted the third, each of those three rulings shows up in our data set.[35] To understand how the final-resolution variables were coded, one should understand that denial of summary judgment does not result in a final resolution. Instead, denial of summary judgment means that there is an unresolved

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[34] 35 USC § 102.

[35] To be clear, while we included merits rulings on each issue, we did *not* include the issue if the court denied the motion as moot. For instance, if the court granted summary judgment of anticipation on the merits and simultaneously denied summary judgment of obviousness as moot, we included anticipation but not obviousness.

disputed issue of material fact.[36] Consequently, denials of summary judgment alone do not result in a final ruling in either direction. If, however, the issue had been resolved at trial, then the final ruling was coded as the trial resolution. If summary judgment had been granted on an issue, then the summary judgment ruling was coded as the final resolution in our coding.[37] We coded decisions that finally ruled for a party on an issue as definitive wins, and decisions that ruled for a party but kept the issue alive (largely denials of summary judgment but also remands on appeal) as interim wins.

B. Technology and Industry Classifications

The heart of this Article is our comparison of outcomes across the technology and industry categories of the asserted patents. Our technology categories refer to the nature of the invention itself, while our industry categories focus on the owner of the patents and the industry in which the technology is put to use. In one instance (biotechnology), we use the same term to describe both the technology and the industry; a patent on a gene sequence used in gene therapy is both a biotechnology technology and used in the biotechnology industry. But the two uses of the term are far from identical.[38] In this and many other categories, there is substantial but not complete overlap between the technology and industry categories. Some patents that cover software technology are employed in traditional software industries like computers and electronics, but software as a technology also shows up in a

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[36] See FRCP 56.

[37] Of course, if the Federal Circuit reversed a ruling relating to a patent on appeal, we updated the final-resolution coding to reflect the appellate decision. If the ruling was reversed on appeal, we retained the original decision in our summary judgment coding (though not our final-resolution coding) because we wanted to capture summary judgment win rates at the trial court. We don't believe that this coding decision meaningfully affects our results. Many grants of summary judgment weren't subject to an appeal and most appeals resulted in at least partial affirmance. Even some reversals were retried to the same result. Only a small percentage (less than 10 percent) of patents ruled invalid or not infringed on summary judgment were subject to a complete reversal followed by settlement in our data set.

[38] A substantial majority of patents covering biotechnology techniques—that is, biotechnology as a technology—were assigned either to the medical industry because the patented technology's covered use was for medical diagnostics or other medical techniques, or to the pharmaceutical industry because the technology produced a covered pharmaceutical drug. Patents covering biotechnology as a technology were assigned to the biotechnology industry only when the invention purported to advance the state of the science of biotechnology and the patent did not reveal a definite medical or pharmaceutical application.

wide array of other industries, from transportation/automotive to consumer goods, industrial goods, energy, and medical devices/methods.

While the PTO has a technology classification scheme, it was not created for the purpose of defining technologies at a conceptual level, and it possesses other serious shortcomings that have been discussed in connection with prior research published by two of this Article's authors.[39] We wanted a series of broad categories that would capture inventions of different types. As a result, one of us (John Allison) evaluated all of the patents in our study by hand and categorized them into one of six different technology areas and one of eleven different industry categories.

1. Technology areas.

When determining the technology area to which an invention should be assigned, we placed emphasis on the claims, sometimes aided by the written descriptions and drawings to explain ambiguous claim terms. When further required to interpret a term in the claims, we occasionally consulted technical dictionaries, encyclopedias, and the Internet, although we rarely had to resort to such extrinsic sources. We first assigned each patent in our data set to a single, primary technology area. In the case of approximately one-third of the patents, we also identified one or, rarely, two or more secondary technology areas. This secondary assignment was done when another technology area clearly formed an additional but integral part of the claims. When both primary and secondary technology areas are included, the 945 patent-case pairs had a total of 1,237 technology areas for an average of 1.31 technology areas per patent-case pair. The six primary technology areas are thus mutually exclusive, while the primary-plus-secondary areas are not.

The technology areas are defined as follows:

(1) Mechanical: An invention in which the claims cover the use of mechanical parts, either solely or predominantly, sometimes combined with heat, hydraulics, pneumatics, or other power sources or power-transfer techniques.

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[39] See John R. Allison, et al, *Valuable Patents*, 92 Georgetown L J 435, 438 n 15 (2004) (discussing these shortcomings). When a researcher works with an extremely large data set such that it is not feasible to study each patent in depth as was done here, reliance on PTO classifications or International Patent Classifications may be an unavoidable shortcut.

(2) Electrical: An invention in which the claims cover the use of traditional electrical circuitry or the storage or transmission of electric energy.

(3) Chemistry: An invention in which the claims cover chemical reactions, chemical compounds with specific elements and proportions, and chemical processes specifying elements and amounts or proportions. Closely related inventions such as those on purportedly novel metal alloys and nonmetallic composites are also included when the claims cover the specific components and proportions of such amalgams. This technology area includes small-molecule chemistry; DNA, antibodies, and other large molecules are included in the biotechnology category instead. Although many of the chemistry-technology patents were assigned to the pharmaceutical industry category, they are also found in other industry categories, such as the semiconductor category.

(4) Biotechnology: An invention in which the claims cover processes 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 not to disaggregate these techniques into separate technology areas.[40]

(5) Software: An invention in which the claims cover data processing—the actual manipulation of data (and not merely transmission, receipt, or storage of data), regardless of whether the code carrying out such data processing is on a magnetic storage medium, embedded in a chip (firmware), or resident in flash memory.

(6) Optics: An invention in which the claims cover the use of light waves or light energy.

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40 We employ the term "biotechnology" to describe both a technology area and an industry because the term seems to us to be the most accurate one in each case. As used here, to describe a technology, we are concerned only with scientific technique and not with how the results of the scientific technique are ultimately employed. The scientific techniques of biotechnology can be employed in different industries. Many of the patents assigned to biotechnology as a technology category find their way into the pharmaceutical industry category, which is discussed below. This occurs when the result employing the scientific techniques of biotechnology (the technology) is a therapeutic drug. When the technology of biotechnology produces a means for diagnosing a disease or disease propensity, the patent is properly assigned to the medical industry category. When a patent with a technology classification of biotechnology represents an advance in the science of biotechnology itself, its proper industry home is biotechnology.

We also assigned certain patents in the primary software classification to one of that technology's subsets—namely, software business methods. As we defined it, the software business-method category includes software patents that cover models, methods, and techniques 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 whose claims obviously covered only such things as automated generation of customer proposals, advertising, financial techniques, and the use of online catalogs. We do not include computer-controlled manufacturing methods in the business-method category because these methods are not customarily viewed as being within the definition of a business-method patent, although a very broad definition could plausibly contain them. Because the business-method category is a subset of software generally, it is not included in multiple regressions that also include the broader software category.[41] We did, however, run some regressions including software business-method and software non-business-method patents as mutually exclusive categories that substitute for the broader software category.[42]

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[41] It is possible to include the software superset and one of its subsets (business methods or non–business methods) in the same regression-model specification, but not the superset and all of its subsets. We believe it to be far more easily understandable, and thus a better practice, to adopt one model specification with the software superset and a separate model specification with the two subsets of software business methods and software non-business methods.

[42] We used logistic regression (or logit) models, because each of our dependent variables (specific outcomes) is binary (yes or no). Although multivariate regression assumes that all observations are independent of one another, this assumption does not hold when applied to studies of patent infringement litigation. There are several reasons for this: (1) many cases involve the assertion of multiple patents, decisions about these patents are made by the same judge and jury, and sometimes two or more of the patents asserted in the same case originated with the same original patent application; (2) it is common to find in a data set that the same patent has been litigated in multiple separate lawsuits against different defendants, and even though the decision makers may be different, the same patent has the same attributes in each case; and (3) some cases will be consolidated, with the same decision maker deciding certain issues—usually only pretrial summary judgments, but sometimes trial decisions as well. See John R. Allison, Mark A. Lemley, and Joshua Walker, *Patent Quality and Settlement among Repeat Patent Litigants*, 99 Georgetown L J 677, 678–79 (2011); John R. Allison and Mark A. Lemley, *Empirical Evidence on the Validity of Litigated Patents*, 26 AIPLA Q J 185, 245 (1998); Kesan and Ball, 84 Wash U L Rev at 261 (cited in note 17). To remedy the lack of complete independence among observations, we simultaneously clustered on the standard errors of both the unique patent numbers and the cases, because both the patents and the lawsuits were sources of observational correlation.

2. Industry categories.

Unlike technology areas, the industry categories focused more attention on the business use of the patent than on the nature of the technology itself. Although we paid attention to the claim language in assigning a patent to one of eleven mutually exclusive industry categories, we found it necessary to focus more attention on the written description and on extrinsic evidence, especially from the Internet.

(1) Computer and other electronics: This industry encompasses inventions of all kinds that purport to advance the state of the art in computing or computer-device manufacturing, or to enhance users' experiences in employing computing technology. This category includes software and computer-hardware inventions that seek to serve the aforementioned purposes. Also included are inventions predominated by the use of traditional electronic circuitry when those inventions purport to advance the art in that technology or enhance users' experiences in employing electronics technology. In contrast to our prior studies, here we combine the computer and traditional-electronics industries because we find fewer and fewer patents covering traditional electronics without also including significant data-processing elements. Traditional electronics inventions without data-processing elements do continue to exist, but their frequency and importance are rapidly declining—the industries clearly have been merging for quite some time.

(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. Technologies employed in semiconductor-industry inventions may include software, chemistry, optics, and mechanics.

(3) Pharmaceutical: The pharmaceutical industry category includes patents on drugs for treating diseases or other abnormal conditions in humans or animals, as well as processes for producing or using such drugs. The technologies found in pharmaceutical-industry inventions are overwhelmingly chemistry or biotechnology.

(4) Medical devices, methods, and other medical: This industry category includes nonpharmaceutical, nonbiotechnology 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 this category. All of the different technology fields are represented in the medical industry category.

(5) Biotechnology: This category includes those inventions that are in the biotechnology technology category that do not relate to the production of pharmaceutical compositions or medical diagnostics or treatment but that instead purport to advance the science of biotechnology itself.

(6) Communications: The communications industry category includes inventions of all kinds intended to advance the state of the art in communications. Technologies represented in the communications industry include software, electronics, optics, and mechanics.

(7) Transportation (including automotive): This category includes patents on any type of invention related to the production of automobiles or vehicles of any other kind intended for transporting people or cargo, as well as inventions related to the provision of transportation services. Several different technology areas are represented in this industry category.

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

(9) Energy: This category includes inventions of any kind associated with power generation, transportation, or consumption.

(10) Goods and services for consumer uses: This category includes patents on products and services of all kinds intended for personal consumer purposes—that is, goods and services for retail uses that are not in another, more specific category. Many software-implemented business-method inventions are included in this category.

(11) Goods and services for industrial and business uses: This category includes patents on products and services of all kinds intended for industrial and business purposes—that is, goods and services for wholesale uses that are not in another, more specific category. Many software-implemented business-method inventions are included in this category.

C. Potential Limitations

Our data set and the implications that can be drawn therefrom are subject to several limitations. For brevity, we discuss three important limitations here.

First, our data set is limited to lawsuits filed in the years 2008 and 2009. Thus, it is only a snapshot of the larger flow of litigation. The exact beginning and ending points of our data set—January 1, 2008, and December 31, 2009—are artificial cutoffs. Obviously, which suits were brought just inside and outside the time period may be due, in part, to chance. These cases are sufficiently recent, in our opinion, that the results are generally applicable today. However, there have been several legal changes in the interim that may make lawsuits today different from those in our data set. The most salient changes are the passage of the Leahy-Smith America Invents Act[43] in 2011, the Federal Circuit's en banc *Therasense* decision[44] in 2011, and four Supreme Court cases involving the doctrine of patentable subject matter decided in 2010,[45] 2012,[46] 2013,[47] and 2014.[48] The Federal Circuit also issued several opinions involving patent damages, which may have affected litigant behavior and settlement during the period of our study.[49] These opinions may influence what issues litigants press and, separately, which cases reach the stage of a ruling on the merits. So too may Supreme Court decisions that change the availability of attorney's fees to prevailing defendants.[50] Accordingly, the cases filed today may differ from those that we studied. And some of the cases in our data set were decided under Supreme Court and Federal Circuit opinions issued after the respective cases were filed. These subsequent legal changes may

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43 Pub L No 112-29, 125 Stat 284 (2011), codified in various sections of Title 35.

44 *Therasense, Inc v Becton, Dickinson and Co*, 649 F3d 1276, 1296 (Fed Cir 2011) (en banc) (holding that the appropriate standard for intent to deceive is the "knowing and deliberate" standard).

45 *Bilski v Kappos*, 561 US 593, 612–13 (2010) (holding that the machine-or-transformation test is not the exclusive test for patentable material).

46 *Mayo Collaborative Services v Prometheus Laboratories, Inc*, 132 S Ct 1289, 1302, 1305 (2012) (noting that the machine-or-transformation test is an important and useful clue to patentability but does not trump the "law of nature" exclusion, and holding that the patents were invalid because they effectively claimed the underlying laws of nature).

47 *Association for Molecular Pathology v Myriad Genetics, Inc*, 133 S Ct 2107, 2118–19 (2013) (holding that isolated DNA is not patent eligible, because it involves a naturally occurring segment of DNA, but that synthetically created DNA is not naturally occurring and can therefore be patented).

48 *Alice Corp Pty Ltd v CLS Bank International*, 134 S Ct 2347, 2355–57 (2014).

49 See, for example, *Uniloc USA, Inc v Microsoft Corp*, 632 F3d 1292, 1315 (Fed Cir 2011) (prohibiting the use of the 25 percent rule of thumb for calculating reasonable royalties); *ResQNet.com, Inc v Lansa, Inc*, 594 F3d 860, 873 (Fed Cir 2010) (vacating the district court's damages award because the reasonable royalty determination relied on speculative evidence).

50 See, for example, *Octane Fitness, LLC v Icon Health & Fitness, Inc*, 134 S Ct 1749, 1755–56 (2014).

have been unforeseeable to the patent owners when they originally elected to initiate lawsuits, when the PTO originally examined the underlying patent applications, and when the patent attorneys drafted the applications.[51]

Second and perhaps more importantly, our data set contains only patents that were subject to a ruling on summary judgment, a trial, or an appeal. To be sure, we have the entire population of cases that resulted in a ruling on a dispositive motion or trial. For these cases, we report statistical results on the outcomes. However, most lawsuits settle, and as our data confirm, most lawsuits settle before any ruling on the merits.[52] Cases that settled before any substantive patent ruling are completely absent from our data set. Moreover, many patent disputes don't result in litigation.[53] Our data set lacks unlitigated disputes about patents. The upshot is that our data and results are not generalizable to the cases or disputes that settled without any substantive ruling. Thus, while our data shed light on who wins and loses patent cases and dispositive motions, the data cannot tell us who *would* win cases that are filed but settled without a judgment.[54]

We do not even have a sense of which direction the bias, if any, would point if one were interested in all litigated cases. On the one hand, it may be that the cases that are settled before a merits ruling are mainly strong cases in which the parties overlapped in their expectations of success. If this were true, then the defendant win rates we observe in our data set would be higher than the win rates if all cases were litigated to judgment. On the other hand, it could be that the cases that settled before a merits ruling consist disproportionately of meritless cases that

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51 See David L. Schwartz, *Retroactivity at the Federal Circuit*, 89 Ind L J 1547, 1550 (2014) (arguing that many Federal Circuit opinions have a weak prospective effect on future patents but a strong retroactive effect on existing patents).

52 See Mark A. Lemley, *Rational Ignorance at the Patent Office*, 95 Nw U L Rev 1495, 1501 (2001) ("The overwhelming majority of [patent] lawsuits settle or are abandoned before trial."); Kesan and Ball, 84 Wash U L Rev at 271–73 (cited in note 17) (finding that the vast majority of patent cases settle).

53 See Lemley, 95 Nw U L Rev at 1507 (cited in note 52) (estimating that only 1.5 percent of patents are litigated).

54 Litigation and settlement incentives are extremely hard to quantify or observe. The incentives are likely influenced by many factors, including the venue of the litigation. See Allison, Lemley, and Schwartz, 92 Tex L Rev at 1793 (cited in note 4) (reporting diversity in case outcomes in patent litigation in eight distinctly busy patent districts). In our previous work, we have provided a comparison between filed lawsuits by district and our data set of adjudicated patents. See id at 1778–81.

were resolved via cost-of-defense settlements.[55] If this alternative hypothesis were true, then our estimates of defendant win rates from the cases that reached the merits phase would be lower than the defendant win rate if all filed cases went to judgment. Because almost all settlements are confidential,[56] we cannot assess the direction of the bias.

Third, the size of our data set is relatively modest, with fewer than one thousand patent observations. This is not a sample; we report the full population of merits decisions for lawsuits in the years 2008 and 2009.[57] However, once the data set is broken down by technology and further still by patent-law doctrine, the number of observations in each category becomes much smaller, making statistical significance harder to find. We urge readers to interpret our results with these three limitations in mind.

III. RESULTS

A. Descriptive Statistics by Technology and Industry

Consistent with past evidence of the growing diversity of patent litigation, we find that mechanical patents no longer dominate other technology types in litigation that reaches a merits decision. As Table 1 demonstrates, software patents (not mechanical patents) are the single largest category of decided cases, accounting for more than one-third of all outcomes in our data set. Just over a quarter of outcomes are mechanical, and just over 20 percent are chemical or biotechnological. More than 45 percent of cases are software or electronics cases.

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55 Such claims may be common. See Mark A. Lemley and A. Douglas Melamed, *Missing the Forest for the Trolls*, 113 Colum L Rev 2117, 2163 (2013) (stating that patent trolls pursue a large number of cases, many of which a practicing entity would probably not bring, but that these cases are more likely to settle quickly). Moreover, prior research has shown that patent owners who assert their patents many times lose more often than owners who assert patents less frequently. See Allison, Lemley, and Walker, 99 Georgetown L J at 712 (cited in note 42).

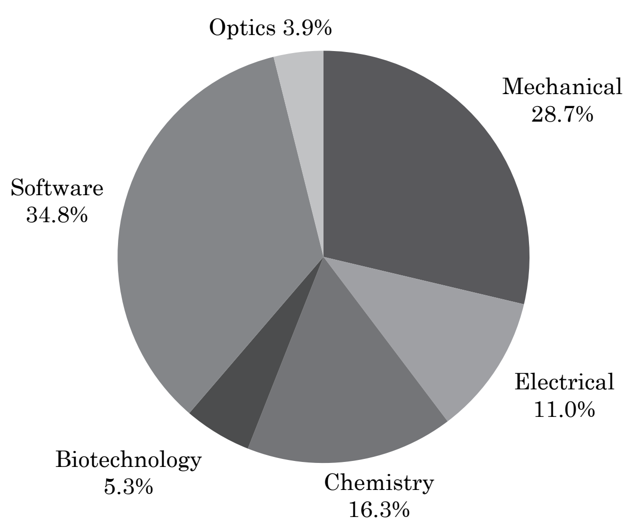
56 See Scott A. Moss, *Illuminating Secrecy: A New Economic Analysis of Confidential Settlements*, 105 Mich L Rev 867, 869 (2007) ("*Public* settlements are the exception, common in only a few types of cases.").

57 Because our data set is a population, we are not merely inferring things about a population from a sample. By definition, any difference observed in a population is statistically significant. However, we generate inferential statistics in our regressions as though we were inferring things from a sample about the population from which the sample was drawn. We do this because readers may wish to extrapolate from our findings to a period of time outside the date parameters of our population.

TABLE 1. PATENT DECISIONS BY TECHNOLOGY

Technology	Frequency	Percentage
Mechanical	271	28.7%
Electrical	104	11.0%
Chemistry	154	16.3%
Biotechnology	50	5.3%
Software	329	34.8%
Optics	37	3.9%
Total:	945	100.0%

FIGURE 1. PATENT DECISIONS BY TECHNOLOGY



Because many of the complaints about software patents are directed to a particular subset of those patents that cover business methods, we also ran an alternative specification in which we separated patents covering business methods from other, more traditional software patents.[58] In this alternative specification, 65 of the software patents were software business-method patents and 264 were software non-business-method patents.

As with technologies, the industry results likewise show that no one industry dominates in our data set of merits decisions.[59] The two largest industry clusters are (1) consumer goods and services (retail) and industrial/business goods and services (wholesale), with a combined total of 34.8 percent of all merits decisions; and (2) computer and other electronics and communications, with a combined total of 26.7 percent of all merits decisions. It is notable that all four of the industry groupings in these two clusters contain substantial numbers of software patents. In particular, the latter cluster of two industries includes quite a few patents on software business methods. Medical devices and pharmaceuticals both account for a sizable share of litigated patent outcomes.

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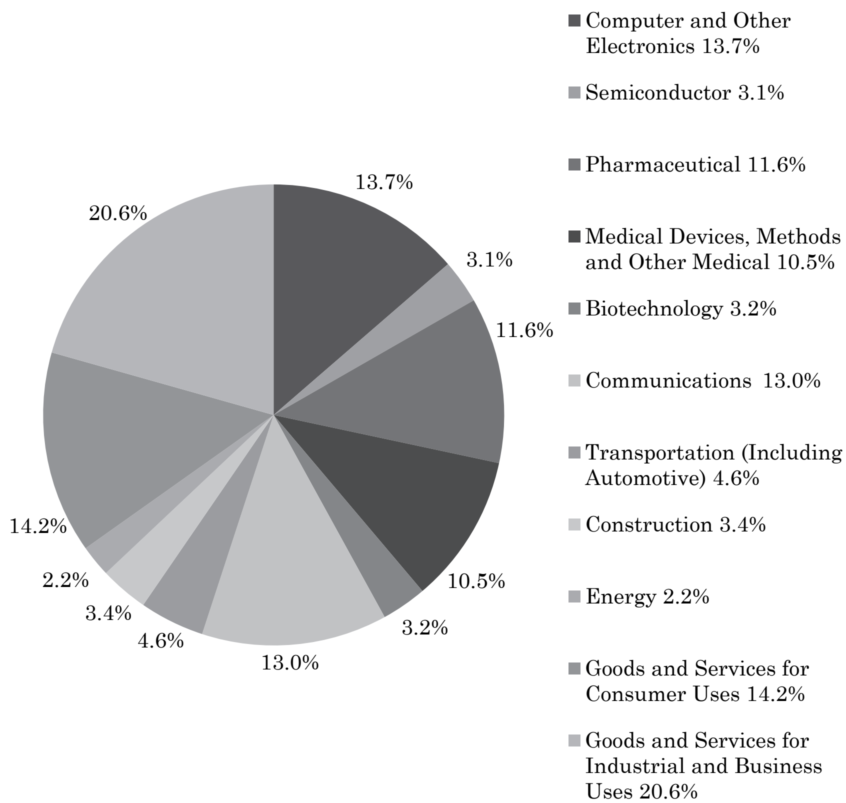
58 As observed in Part II.B.1 in our technology-area definitions, all of the litigated patents covering business methods were within the primary software classification.

59 Our unit of observation is the resolution of a claim over a particular patent in a particular case (the patent-case pair). Some cases include multiple patents, and when that is true, each patent outcome is given a separate entry in our data. Similarly, some patents are litigated in multiple cases, and when that is true, each is given a separate entry. For simplicity we sometimes refer to resolution of "cases" or "disputes," but unless we say otherwise, each unit of observation in our study is a patent-case pair.

TABLE 2. PATENT DECISIONS BY INDUSTRY

Industry	Frequency	Percentage
Computer and Other Electronics	129	13.7%
Semiconductor	29	3.1%
Pharmaceutical	110	11.6%
Medical Devices, Methods, and Other Medical	99	10.5%
Biotechnology	30	3.2%
Communications	123	13.0%
Transportation (Including Automotive)	43	4.6%
Construction	32	3.4%
Energy	21	2.2%
Goods and Services for Consumer Uses	134	14.2%
Goods and Services for Industrial and Business Uses	195	20.6%
Total:	945	100.0%

FIGURE 2. PATENT DECISIONS BY INDUSTRY



B. Outcomes by Technology Area

We find dramatic differences in how patent owners in different industries and technologies fare in the cases that reach a definitive result in litigation.[60] Our statistics on final results exclude cases in which there was a summary judgment denial followed by a settlement before trial.[61] As we reported in our

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60 A Pearson chi-square test for significances in outcome differences shows that we can easily reject the hypothesis that there is no difference by technology area ($p = 0.000$).

61 Presumably, many of these excluded cases involve a monetary payment to the patentee. This selection issue should be taken into account when considering the statistic that infringers win approximately three-quarters of the patent cases that end with a

companion paper, patentees overall won just 26 percent of cases that went to a definitive outcome.[62] But that overall percentage conceals remarkable variation by technology area. Chemical patents (many of which are owned by pharmaceutical companies) won a majority of their cases that went to a final decision (62 of 119, or 52.1 percent). By contrast, software patents prevailed in only 30 out of 223 cases, or 13.5 percent. That difference is consistent with the received wisdom in the literature that patents are stronger and more valuable in disciplines like chemistry than in software.[63] However, for reasons previously discussed, data on win rates cannot necessarily be extrapolated to make inferences about all patents or even all litigated patents.

When we separated business-method and non-business-method patents, we found that business-method patents actually fared substantially better than other sorts of software patents, which tended to cover more technical software inventions. Patent owners won 17 percent of the business-method patents in cases that went to a final decision, compared with only 12 percent of the non-business-method patents.[64] This suggests that the low win rate for software patents cannot be attributed solely to business-method patents.

More remarkable are the findings for biotechnology patents, which had the lowest patentee win rate of any technology area. Only two out of thirty-six, or 5.6 percent, of biotechnology patentees that took a case to a final decision prevailed. Most policy advocates lump chemistry and biotechnology patents together, arguing that we need strong patent protection in those areas (even if not elsewhere) because of the cost and uncertainty associated with biomedical inventions. But our data set suggests

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definitive ruling. Patentees often get paid even without a definitive ruling, particularly if they have managed to avoid losing pretrial.

62 Allison, Lemley, and Schwartz, 92 Tex L Rev at 1787 (cited in note 4) ("Patentees won only 164 of the 636 definitive merits rulings.").

63 See, for example, Bessen and Meurer, *Patent Failure* at 15–16 (cited in note 12) (arguing that the patent system is beneficial to society only in the life sciences and not elsewhere).

Notably, prior work by two of this Article's authors found that software patents were quite unlikely to prevail. See Allison, Lemley, and Walker, 99 Georgetown L J at 707–09 (cited in note 42). But that study was limited because it focused on the most-litigated patents—those that had been litigated eight or more times during the 2000–2009 period. This Article provides the first evidence that those software patents that reach the stage of a merits ruling disproportionately lose in court.

64 The differences among the seven technology areas are statistically significant ($p = 0.000$).

that the biotechnology patents that reach a merits ruling overwhelmingly lose.[65]

TABLE 3. DEFINITIVE WIN RATE BY TECHNOLOGY

Patent Owner, Definitive Winner	Frequency	Percentage	Total
Mechanical	45	27.1%	166
Electrical	21	30.9%	68
Chemistry	62	52.1%	119
Biotechnology	2	5.6%	36
Software	30	13.5%	223
Optics	4	16.7%	24
Total:	164	25.8%	636

Pearson $\chi^2(5) = 69.9983$; $p = 0.000$[66]

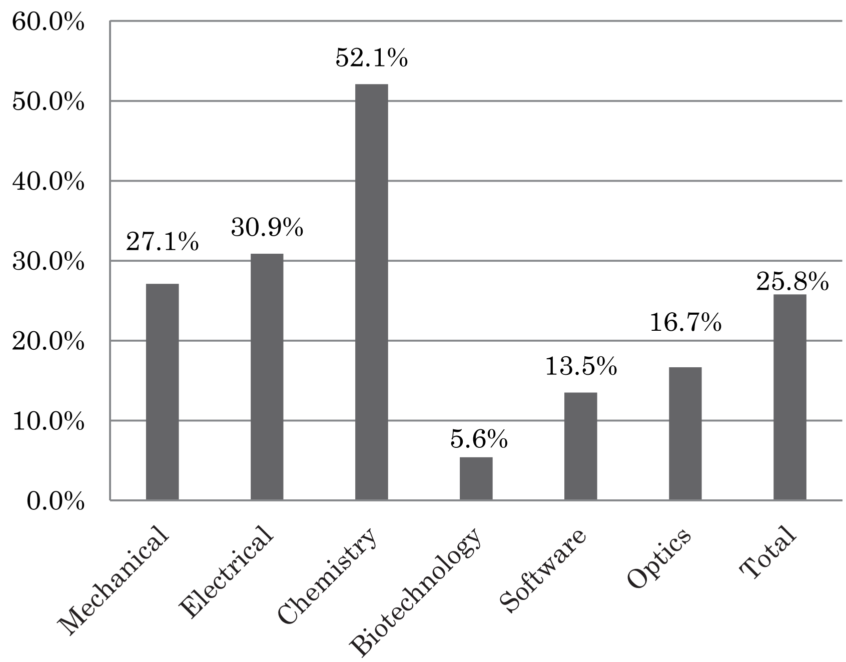
[65] Seven of the invalidated biotechnology patents were part of *Association for Molecular Pathology v Myriad Genetics, Inc*, 133 S Ct 2107 (2013) ("Myriad"). *Myriad* is the only case in our data set that the Supreme Court reviewed on either validity or infringement. The Federal Circuit had found some of these seven patents valid, a decision reversed by the Supreme Court.

As this article was going to press, we read Christopher Holman's comment on this paper. See generally Christopher M. Holman, *Do Biotech Patent Lawsuits Really "Overwhelmingly Lose?": A Response to* Our Divided Patent System, 34 Biotech L Rep 59 (2015). We thank him for the careful and detailed analysis of the biotechnology cases that we identified. Holman correctly discovered that one of our cases was incorrectly coded as a biotechnology case when it was not. We corrected the error and updated our results in this Article. Because that was one of the three cases we had coded as a plaintiff victory, the biotechnology win rate actually drops to 5.6 percent as a result of Holman's correction.

Holman argues that biotechnology patentees do better than we find. The difference is likely explained by a difference in counting wins. We included in our data as patentee definitive wins only those cases that resulted in a judgment for the patentee. Holman, by contrast, appears to treat a biotechnology patentee as prevailing if at least one party paid it money in settlement, even if the patent was later invalidated in court or held not infringed.

[66] As explained in the introduction to our technology-area definitions, we also ran an alternative specification in which we allowed patents to be coded in a secondary as well as a primary technology area. That increased the number of technology-area observations substantially, from 636 definitive merits outcomes to 777. But it did not have a large effect on the results, with one exception: the patentee win rate in the electrical technology category dropped from 30.9 percent to 20.9 percent, likely as a result of having some software patents (which fared poorly as a class) receive a secondary classification as electronic patents.

FIGURE 3. DEFINITIVE WIN RATE BY TECHNOLOGY



We can gain further insight by breaking down the results by both the stage of litigation and the reason for patentee loss. Table 4 shows that our results are driven by a combination of differences in invalidity findings and noninfringement findings, with different technologies faring better on one front than another. While roughly 43.0 percent of patents that went to a final judgment on validity were invalidated, the technology-specific numbers ranged from a low of 21.4 percent for optics and 25.6 percent for chemistry to a high of 80.0 percent for biotechnology. Interestingly, mechanical patents were invalidated more often than not (52.2 percent of the time). Software was only slightly above the average; software patents were invalidated 45.3 percent of the time. When we separated software into business-method and non-business-method categories, we found that software business-method patents were more likely than software non-business-method patents to be invalidated (56.4 percent of software business-methods patents were held invalid compared with 41.4 percent of software non-business-method patents).

TABLE 4. INVALIDITY RATE BY TECHNOLOGY

Invalidity, All Grounds (Any Stage)	Frequency	Percentage	Total
Mechanical	60	52.2%	115
Electrical	22	38.6%	57
Chemistry	23	25.6%	90
Biotechnology	12	80.0%	15
Software	68	45.3%	150
Optics	3	21.4%	14
Total:	188	42.6%	441

Pearson $\chi^2(5) = 26.9771$; $p = 0.000$
Note: Validity and invalidity decisions are conditioned on a final determination of a validity dispute.

FIGURE 4. INVALIDITY RATE BY TECHNOLOGY

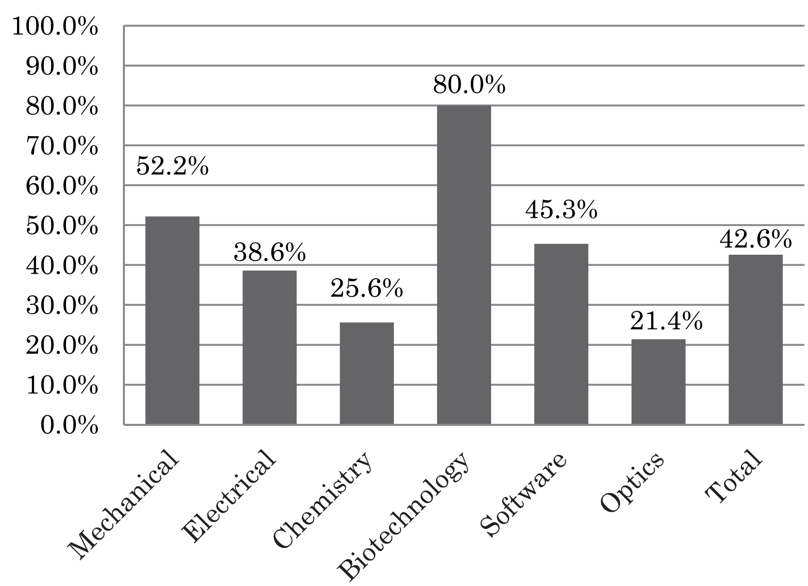
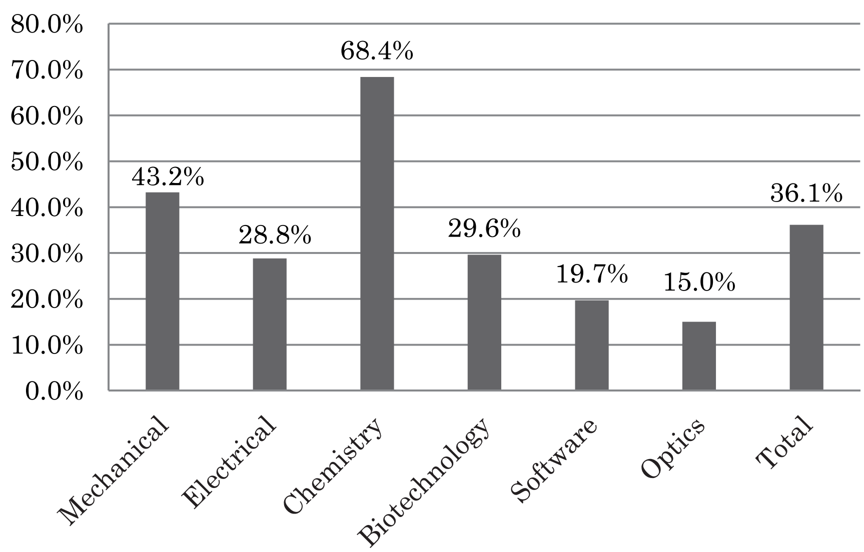


TABLE 5. INFRINGEMENT RATE BY TECHNOLOGY

Direct Infringement, Literal plus DOE (Any Stage)	Frequency	Percentage	Total
Mechanical	64	43.2%	148
Electrical	17	28.8%	59
Chemistry	67	68.4%	98
Biotechnology	8	29.6%	27
Software	38	19.7%	193
Optics	3	15.0%	20
Total:	197	36.1%	545

Pearson $\chi^2(5) = 76.7483$; $p = 0.000$
Note: Infringement decisions are conditioned on a final determination of an infringement dispute.

FIGURE 5. INFRINGEMENT RATE BY TECHNOLOGY



The infringement numbers tell a story that is similar to the validity results in some ways and different in others. Optics patents are not only the least likely to be invalid in our data set but also the least likely to be infringed (only three out of twenty cases—15 percent—that resolved infringement found the patents to be infringed). Software patents fare only slightly better, with only 38 out of 193 cases (19.7 percent) that resolved an infringement dispute finding infringement. Breaking that into business-method and non-business-method patents reveals that 28.6 percent of software business-method patents and 17.0 percent of software non-business-method patents are found infringed. By contrast, chemistry patents won infringement disputes more than two-thirds of the time (sixty-seven out of ninety-eight times, or 68.4 percent). The chemistry result is not surprising, since many chemistry-technology cases involve suits against generic-drug manufacturers that have to copy the basic technology in order to be eligible for expedited FDA approval.[67] In some of these lawsuits, the generic defendant apparently did not contest infringement but instead stipulated the issue.

These percentages do not tell the whole story, however, because some types of arguments are made more often in some industries than in others. For instance, while litigated biotechnology patents faced a higher invalidity rate (80.0 percent) than noninfringement rate (70.3 percent), there were more noninfringement decisions than invalidity decisions in biotechnology, meaning that when a biotechnology patentee lost, it was more likely to lose on noninfringement grounds (nineteen cases) than on invalidity grounds (twelve cases). To account for this, in Table 6 we show the number of results of each type by technology area.[68] Table 6 demonstrates that across all technologies, the chance of a patent being held not infringed was significantly higher than the chance of it being held invalid. That was true in every technology area, but the result was particularly striking in the optics and software industries, in which more than two-thirds of all the cases we observed included a finding of noninfringement. Overall, there were almost twice as many noninfringement rulings (348) as invalidity rulings (188). The difference in infringement and validity rates in software may shed some light on debates about software. While some complain that software patents are excessively broad, our findings suggest that courts are not finding those patents excessively broad. Instead, it may be that software patent holders are overasserting

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67 See Christopher A. Cotropia and Mark A. Lemley, *Copying in Patent Law*, 87 NC L Rev 1421, 1444 (2009) ("Because of the mechanics of the Hatch-Waxman Act, generic pharmaceutical defendants necessarily must copy the plaintiff's active ingredient to achieve bioequivalence."). See also C. Scott Hemphill and Mark A. Lemley, *Earning Exclusivity: Generic Drug Incentives and the Hatch-Waxman Act*, 77 Antitrust L J 947, 952 (2011) (explaining that many generic-drug firms attempt to enter the market prior to the expiration of the brand-name patents, thereby infringing on the brand-name patents).

68 Note that in Table 5 the percentages do not add to 100 percent because in some cases a patent claim was held both invalid and not infringed.

their patents in litigation, rather than overclaiming in the claim-drafting sense. It is also possible that the courts and parties themselves are choosing to dispose of the cases on noninfringement instead of invalidity because it is simpler to do so, and that if both issues were adjudicated the noninfringed patents would also be held invalid.[69]

TABLE 6. OUTCOMES FOR PATENT OWNERS BY TECHNOLOGY

Technology	Loss on Invalidity	Loss on Noninfringement	Win	Total Cases
Mechanical	60	84	45	166
Electrical	22	42	21	68
Chemistry	23	31	62	119
Biotechnology	12	19	2	36
Software	68	155	30	223
Optics	3	17	4	24
Total:	188	348	164	636

The differences are not evident at trial or on summary judgment of noninfringement; in neither case are the technology differences statistically significant. We do, however, see significant differences in the willingness of courts to grant summary judgment of invalidity. As Table 7 illustrates, courts are more likely to do so when confronted with biotechnology and software patents. That is particularly true of business-method patents: 43.9 percent of adjudicated summary judgment motions on invalidity for business-method patents were granted, compared to 34.2 percent of software non-business-method patents. But grant rates in both categories were above average.

69 See Roger Allan Ford, *Patent Invalidity versus Noninfringement*, 99 Cornell L Rev 71, 103–12 (2013) (arguing that parties are motivated to litigate too many infringement issues and not enough validity issues).

TABLE 7. WIN RATE OF SUMMARY JUDGMENT MOTIONS BY ACCUSED INFRINGER ON INVALIDITY BY TECHNOLOGY

SJ Invalidity (All)	Frequency	Percentage	Total
Mechanical	34	27.6%	123
Electrical	14	28.6%	49
Chemistry	12	21.1%	57
Biotechnology	11	50.0%	22
Software	57	36.8%	155
Optics	3	15.0%	20
Total:	131	30.8%	426

Pearson $\chi^2(5) = 11.9839$; $p = 0.035$

Note: The summary judgment wins are not strictly comparable to the definitive wins reported above. A defendant that wins summary judgment of invalidity has won the case and is a definitive winner for purposes of Table 3. A patentee that defeats a motion for summary judgment on invalidity on one ground has defeated summary judgment on that issue but has not won the case and so will show up as a winner in this Table but not in Table 3.

Those differences extend to the grounds of invalidity. In Table 8, we present the results for several common invalidity arguments.[70]

TABLE 8. WIN RATE ON PARTICULAR INVALIDITY ARGUMENTS BY TECHNOLOGY

Invalidity, § 102 Prior Art (Any Stage)	Frequency	Percentage	Total
Mechanical	22	37.9%	58
Electrical	6	18.2%	33
Chemistry	9	19.1%	47
Biotechnology	2	33.3%	6
Software	31	40.3%	77
Optics	2	20.0%	10
Total:	72	31.2%	231

Pearson $\chi^2(5) = 25.6518$; $p = 0.000$

[70] Note that, unlike Table 7, the results in Table 8 are from arguments in all procedural postures, not just summary judgment.

Invalidity, § 103 Obviousness (Any Stage)	Frequency	Percentage	Total
Mechanical	37	46.3%	80
Electrical	11	30.6%	36
Chemistry	6	9.7%	62
Biotechnology	2	50.0%	4
Software	16	30.2%	53
Optics	0	0.0%	6
Total:	72	29.9%	241

Pearson $\chi^2(5) = 25.6518$; $p = 0.000$

Invalidity, § 112 Indefiniteness (Any Stage)	Frequency	Percentage	Total
Mechanical	0	0.0%	19
Electrical	7	31.8%	22
Chemistry	1	3.0%	33
Biotechnology	0	0.0%	3
Software	22	24.4%	90
Optics	1	12.5%	8
Total:	31	17.7%	175

Pearson $\chi^2(5) = 15.5658$; $p = 0.008$

Invalidity, § 112 Inadequate Disclosure (Any Stage)	Frequency	Percentage	Total
Mechanical	11	26.8%	41
Electrical	3	10.0%	30
Chemistry	8	18.2%	44
Biotechnology	3	75.0%	4
Software	5	16.7%	30
Optics	0	0.0%	16
Total:	30	18.2%	165

Pearson $\chi^2(5) = 15.6934$; $p = 0.008$

The technology differences were statistically significant for all of these grounds for invalidity (though barely above the 95 percent confidence threshold for § 102 prior art). Among the most notable differences are in the grounds for invalidity under § 112.[71] Indefiniteness arguments under § 112(b) were never successful in the mechanical or biotechnology areas and succeeded only 3 percent of the time in chemical patents. By contrast, indefiniteness claims prevailed nearly one-quarter of the time in software patent cases (including in one-third of business-method cases) and nearly one-third of the time in electronics cases. The comparison of success rates for indefiniteness validity challenges in our set of adjudicated patents is consistent with some scholars' arguments that patents are simply less clear in the information technology industries than in other industries.[72] And the success rates may result in part from a specific set of definiteness rules that applies only to software claims written in means-plus-function format.[73] By contrast, arguments based on enablement and written description—that is, arguments about whether the scope of the patent claims was properly supported by the disclosure in the patent—show a very different pattern. One-third of mechanical patent decisions and three-quarters of biotechnology patent decisions on these grounds resulted in invalidity,

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71 35 USC § 112.

72 See, for example, Bessen and Meurer, *Patent Failure* at 107 (cited in note 12). See also Lemley, 2013 Wis L Rev at 930 (cited in note 12) ("Unlike chemistry and biotechnology, where we have a clear scientific language for delineating what a patent claim does and doesn't cover, there is no standard language for software patents.").

73 See, for example, *Aristocrat Technologies Australia Pty Ltd v International Game Technology*, 521 F3d 1328, 1336–38 (Fed Cir 2008) (holding that an algorithm must be disclosed in order for a patent to be upheld); *Function Media, LLC v Google Inc*, 708 F3d 1310, 1318 (Fed Cir 2013); *ePlus, Inc v Lawson Software, Inc*, 700 F3d 509, 518–19 (Fed Cir 2012) (noting that a specific structure or algorithm is required); *Ergo Licensing, LLC v CareFusion 303, Inc*, 673 F3d 1361, 1362–65 (Fed Cir 2012) (holding that the terms "control means" and "programmable control means" were indefinite); *Noah Systems, Inc v Intuit Inc*, 675 F3d 1302, 1312–13 (Fed Cir 2012) (noting that means-plus-functions claims are divided into situations in which there is no algorithm disclosure and situations in which the disclosure is inadequate); *In re Aoyama*, 656 F3d 1293, 1294, 1297–98 (Fed Cir 2011) (finding a means-plus-function software patent claim invalid as indefinite for failure to disclose the corresponding algorithm performing that function); *Typhoon Touch Technologies, Inc v Dell, Inc*, 659 F3d 1376, 1384–86 (Fed Cir 2011) (finding that means-plus-function software claims required disclosure of the corresponding structure performing that function in the specification, but that the structure did not need to be described in the form of software code); *WMS Gaming Inc v International Game Technology*, 184 F3d 1339, 1349 (Fed Cir 1999) ("[T]he disclosed structure is not the general purpose computer, but rather the special purpose computer programmed to perform the disclosed algorithm."). The *Aristocrat* line of cases was developed during the time frame of our data set, which may have resulted in considerable uncertainty about the doctrine. All of the patents in our data set were drafted before the *Aristocrat* line of cases existed, which may explain why so many adjudicated patents in software failed on this issue.

far more than in software and electronics. However, we caution that some of these data sets, such as those for biotechnology, are quite small, which means that a few cases can significantly affect the outcome. Even the sizable difference we observe loses statistical significance once we add our full set of controls, perhaps because the total number of data points is not sufficiently large.[74]

Interestingly, when we divided software patents into business-method and non-business-method categories, we found that the former were less likely to be invalidated on grounds of § 102 prior art (33.3 percent for business methods compared with 43.4 percent for other software) and obviousness (16.7 percent for business methods compared with 34.1 percent for other software).

In prior work based on the same data set, we studied a variety of different patent characteristics—including the domestic or foreign status of the inventors, the number of claims, the prior art references cited, and the number of other patents that cite the patent at issue—and a variety of litigation characteristics, including how old the patent was when the suit was filed, how many defendants were sued, and how many other patents were asserted in the same case.[75] For this Article, we ran a multivariate regression that incorporated each of those variables in addition to the technology categories we have described. The full results are presented in Appendix A. Compared to chemistry patents—our comparison dummy—we find that mechanical, biotechnology, and software patents litigated to judgment are significantly less likely to succeed overall, even when we factor in each of these variables about the patents and the lawsuits. The result is highly significant ($p < 0.01$ in each case). Patents in each of those three technology areas were significantly more likely to be held invalid than chemistry patents ($p < 0.01$ for mechanical and biotechnology patents, and $p < 0.05$ for software patents). And patents in the software and electrical areas (but not biotechnology or mechanical) were significantly less likely to be found infringed than chemistry patents ($p < 0.01$ for software and $p < 0.05$ for electrical).

74 Statistical significance here does not mean that there is a discernible difference between each of the categories; it merely means that we can reject the hypothesis that the difference between a particular category and the other category we use for comparison is due to random chance.

75 See Allison, Lemley, and Schwartz, 92 Tex L Rev at 1772–76 (cited in note 4).

In each of the regression results reported in the Appendices that focus on differences across technology areas, we not only use each technology area as an independent or explanatory variable and test for how each compares with the "comparison dummy" (chemistry) with respect to a given litigation outcome, but we also report the results of an F-test for joint technology effects. The F-test essentially determines whether technology "matters" overall to the litigation outcome, which serves as the dependent variable. In each of the regression results that focuses on industry differences, we likewise report the results of an F-test for joint industry effects—in addition to tests on how a particular industry category compares to the "comparison dummy" (goods and services for consumer uses) for a particular litigation outcome, the results of the F-test reveal whether industry "matters" at all with respect to that outcome.

It bears repeating that although multivariate regression analysis assumes that all variables are independent of one another, this assumption does not hold when one studies patent infringement litigation. There are several reasons for this: (1) many cases involve the assertion of multiple patents, and decisions about these patents are made by the same judges and juries; (2) it is common to find in a data set that the same patent has been litigated in multiple separate lawsuits against different defendants, and even though the decision makers may be different, the same patent has the same attributes in each case; and (3) some cases will be consolidated, with the same decision maker deciding certain issues—usually only pretrial summary judgments, but sometimes trial decisions as well. To account for the lack of complete independence among observations, we simultaneously clustered on the standard errors of the unique patent numbers and the cases, because each is a source of observational interdependence (correlation).[76]

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[76] We also performed bootstrapping as part of our logistic regression analyses, a statistical technique that improves the accuracy of our estimates. The bootstrap method provides an accurate estimate of standard errors when the underlying distribution is unknown by running the regression on random samples of the data many times. See J. Scott Long and Jeremy Freese, *Regression Models for Categorical Dependent Variables Using Stata* 127 (StataCorp 2d ed 2006). We used the Stata statistical-analysis software package. As previously observed, we simultaneously clustered our observations at both the patent and the case level, because observations on the same patents in different cases are likely to be correlated and observations on different patents in the same case are also likely to be correlated. Stata accomplished the bootstrap method as follows: For each regression on a given outcome, Stata took the number of observations for that outcome, divided it into clusters by patent number and case ID number, and drew from the original

Another cautionary note about our logistic regression analyses is required: when running multiple tests from the same data set, it is possible to obtain one or more findings of statistical significance by pure chance (the "false discovery rate," or "FDR" problem).[77] It is rare for a researcher in the social sciences to even mention the problem, because available corrective techniques are too punitive by a large factor. We want to call readers' attention to the issue, however, and caution that there could be a small number of findings of significance in our results that are "false positives," findings of significance that are not real. Thus, one should be hesitant to consider findings of significance at the $p < 0.10$ level as meaningful. It is also possible that a small number of findings at p-values below $p < 0.05$ are not real. Many of our findings of statistical significance are at levels far below 0.05, and a number are well below $p < 0.01$—levels that give us meaningful confidence that what we find is likely to be real. We report the precise p-values in the Appendices. Concerns about false positives are also mitigated by the fact that our general results with respect to technology and industry are consistent among a series of different regression models. Moreover, because our technology and industry categories are highly correlated (a pairwise correlation table is on file with the authors), tests on technologies and industries are not separate, independent tests, which reduces the effective number of tests in our analysis and thus substantially reduces the magnitude of the FDR problem.[78]

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set a random sample corresponding to the number of observations for that outcome. If the particular binary outcome (such as a summary judgment of invalidity granted or not granted) had *X* observations, for example, the size of the random sample was *X*. The resulting random sample was, of course, not identical to the original set from which the sample was drawn, because the randomness of the sampling will miss some of the original observations and duplicate others. Stata then ran the logistic regression on this random sample and substituted the random sample for the original set of the same size. This process of drawing a new random sample with two-way clustering, running the regression, and substituting was repeated one thousand times. The coefficients from the one thousand regressions were used to derive a final p-value and standard error for each coefficient. We followed the same procedure separately for each binary outcome, producing estimates as accurate as if our number of observations were much larger.

77 Statistical techniques for dealing with the FDR problem were developed mainly in the 1990s in response to the newly found ability of scientists in medicine and biotechnology to perform thousands of tests using the same data set. Because these techniques were designed for studies such as these, they do not work well in economics and other social science research, where the number of tests from the same data set are far smaller than those in the hard sciences used in medicine and biotechnology.

78 An FDR corrective technique that is somewhat less punitive than previously developed ones, but may still be too punitive for a study like ours and others in the social sciences, is found in Yoav Benjamini and Yosef Hochberg, *Controlling the False Discovery*

We ran a second regression that included both technology areas and the district in which the lawsuit was filed. We present the results in Appendix B. Our prior research found that patentees were more likely to prevail in some districts than others.[79] While that finding remained true after controlling for technology, the technology differences remained highly significant even after controlling for district. Compared to chemistry patents and controlling for districts, patents in the mechanical, biotechnology, software, and optics technologies were less likely to prevail overall ($p < 0.01$ for all). Mechanical and software patents were more likely to be invalidated than chemical patents ($p < 0.01$).

We also ran an alternate specification in which we distinguished software business-method patents from software patents that were actually directed to technology. In that specification, reported in Appendix C, we incorporate both patent and lawsuit characteristics and a somewhat truncated set of district dummies representing the top three districts.[80] Some of the districts remain significant—the Eastern District of Texas is significantly more likely to rule for patentees ($p < 0.01$). The technology areas are all significant. Relative to chemistry patents (the unreported comparison-technology variable) and taking account of both patent and lawsuit characteristics and district, every other type of technology is significantly less likely to result in a patentee win. For mechanical, biotechnology, software business-method, software non-business-method, and optics patents, this result is highly significant ($p < 0.01$). It is significant at the 95 percent confidence level for electrical and optics patents.

C. Outcomes by Industry

In the previous Section, we focused on the technology at issue in a given patent. In this Section, we look at the outcomes by industry. As we explained in Part II, technology and industry are far from the same. Some software patents are owned by companies in the business of making and selling software, but more of them are deployed in broader industries such as communications, computer and electronics, transportation,

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Rate: A Practical and Powerful Approach to Multiple Testing, 57 J Royal Stat Socy Series B (Methodological) 289, 293–95 (1995).

79 See Allison, Lemley, and Schwartz, 92 Tex L Rev at 1790–95 (cited in note 4).

80 We could not include the full set of districts because of limits on the degrees of freedom.

medical, and various others. As a technology, software inventions pervade almost all industry sectors. Because of the special rules and incentives that exist in the pharmaceutical industry,[81] it is similarly useful to distinguish chemistry-technology patents in general from chemistry patents used in the pharmaceutical industry. For the same reason, mechanical medical devices may have different characteristics than mechanical devices found in other industries. Accordingly, in this Section we ignore the nature of the technology claimed and focus on the industry in which the patent is deployed.

As with technology, we find significant differences in overall outcomes by industry. Table 9 reports the overall patentee win rates by industry. As with technology, biotechnology-industry patent owners fared the worst, winning only 8.3 percent of the cases definitively resolved in our data set. Patentees also fared poorly in communications (14.8 percent win rate), consumer goods and services (15.1 percent win rate), construction (15.0 percent win rate), and computer and electronics (17.1 percent win rate). By contrast, patentees won a majority of cases in the pharmaceutical industry (51.6 percent) and a significant number in the energy industry (40.0 percent). These differences are highly significant ($p = 0.000$).

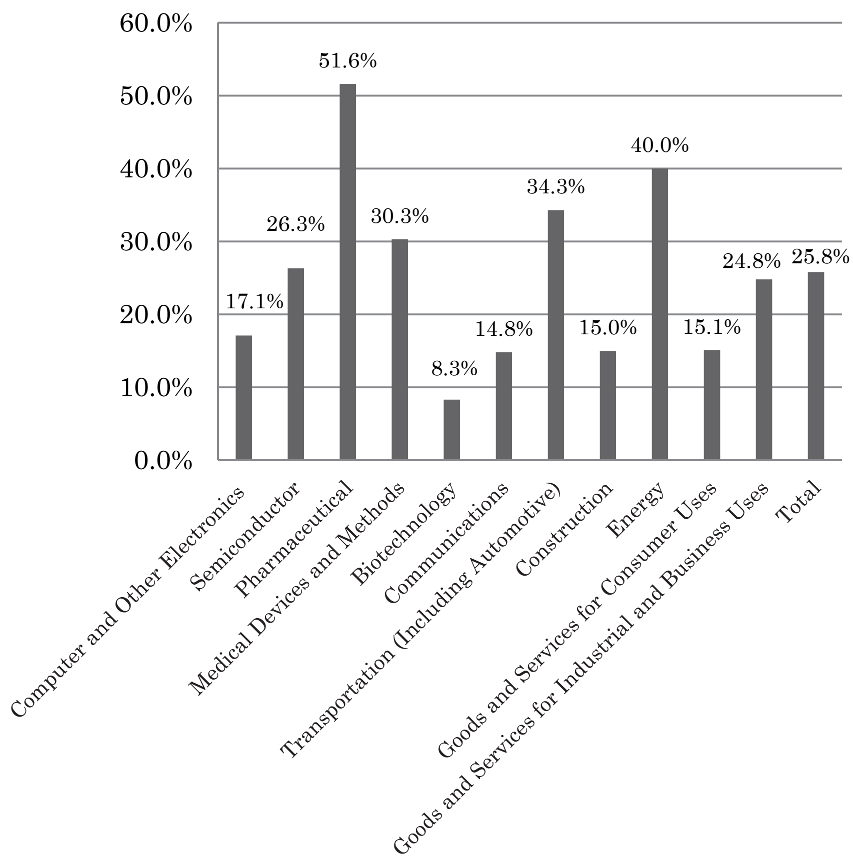
[81] For a discussion of these rules, see Herbert Hovenkamp, et al, 1 *IP and Antitrust: An Analysis of Antitrust Principles Applied to Intellectual Property Law* § 15.2c (Wolters Kluwer 2d ed 2009 and Supp 2012).

TABLE 9. OVERALL PATENTEE WIN RATE BY INDUSTRY

Patent Owner, Definitive Winner	Frequency	Percentage	Total
Computer and Other Electronics	14	17.1%	82
Semiconductor	5	26.3%	19
Pharmaceutical	49	51.6%	95
Medical Devices, Methods, and Other Medical	20	30.3%	66
Biotechnology	2	8.3%	24
Communications	12	14.8%	81
Transportation (Including Automotive)	12	34.3%	35
Construction	3	15.0%	20
Energy	6	40.0%	15
Goods and Services for Consumer Uses	13	15.1%	86
Goods and Services for Industrial and Business Uses	28	24.8%	113
Total:	164	25.8%	636

Pearson $\chi^2(10) = 55.1966$; $p = 0.000$

FIGURE 6. PATENTEE DEFINITIVE WIN RATE BY INDUSTRY



Tables 10 and 11 break down the results by industry for the accused infringer's success rate on invalidity and the patent owner's success rate on infringement.

TABLE 10. FINAL INVALIDITY RULINGS BY INDUSTRY

Invalidity, All (Any Stage)	Frequency	Percentage	Total
Computer and Other Electronics	22	46.8%	47
Semiconductor	3	21.4%	14
Pharmaceutical	19	25.7%	74
Medical Devices, Methods, and Other Medical	25	53.2%	47
Biotechnology	8	72.7%	11
Communications	29	43.3%	67
Transportation (Including Automotive)	13	59.1%	22
Construction	8	80.0%	10
Energy	2	11.8%	17
Goods and Services for Consumer Uses	23	47.9%	48
Goods and Services for Industrial and Business Uses	36	42.9%	84
Total:	188	42.6%	441

Pearson $\chi^2(10) = 33.1555$; $p = 0.000$

FIGURE 7. INVALIDITY RULINGS BY INDUSTRY, ALL GROUNDS (ANY STAGE)

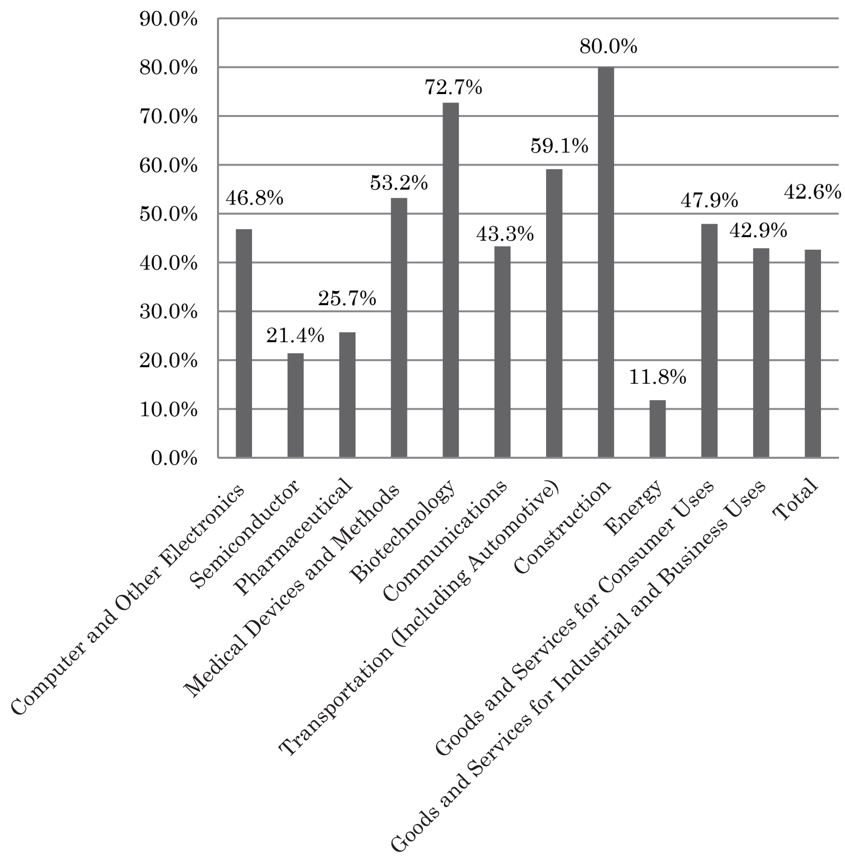
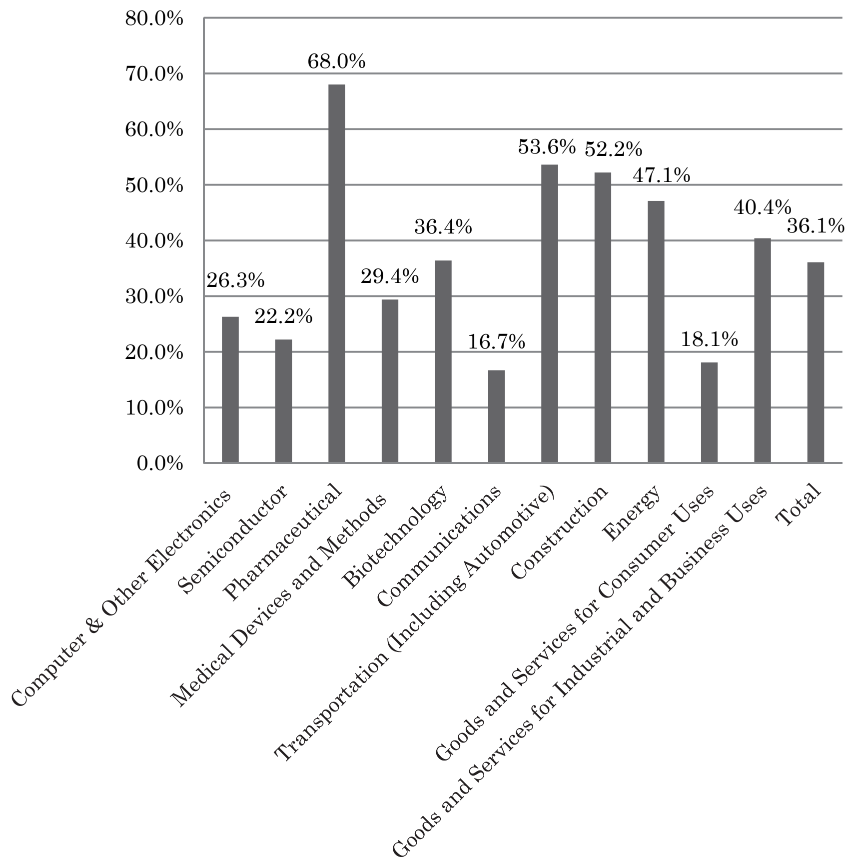


TABLE 11. INFRINGEMENT FINDINGS BY INDUSTRY

Direct Infringement, Literal plus DOE (Any Stage)	Frequency	Percentage	Total
Computer and Other Electronics	21	26.3%	80
Semiconductor	4	22.2%	18
Pharmaceutical	51	68.0%	75
Medical Devices, Methods, and Other Medical	15	29.4%	51
Biotechnology	8	36.4%	22
Communications	10	16.7%	60
Transportation (Including Automotive)	15	53.6%	28
Construction	12	52.2%	23
Energy	8	47.1%	17
Goods and Services for Consumer Uses	13	18.1%	72
Goods and Services for Industrial and Business Uses	40	40.4%	99
Total:	197	36.1%	545

Pearson $\chi^2(10) = 66.8513$; $p = 0.000$

FIGURE 8. INFRINGEMENT FINDINGS BY INDUSTRY



Both invalidity and infringement show significant differences by industry. Patentees won on infringement only 18.1 percent of the time in consumer goods and services and 16.7 percent of the time in communications. Computer and electronics cases and semiconductor cases were also significantly less likely than average to result in a patentee win on infringement. By contrast, patentees won a majority of the infringement disputes in the transportation and construction industries and over two-thirds of the infringement disputes in the pharmaceutical industry. The last result is not too surprising, given that many pharmaceutical patent cases are filed against generics, which copy the technology to take advantage of the regulatory benefits of selling a bioequivalent drug.[82]

The invalidity results tell a rather different story. Patentees lost a majority of invalidity disputes in the transportation and medical-device industries, nearly three-quarters of the invalidity disputes in the biotechnology industry,[83] and a whopping 80 percent of the invalidity claims in construction. By contrast, patentees fared far better in the energy, semiconductor, and pharmaceutical industries, in which one-quarter or less of invalidity challenges succeeded.

As with the technology results, we cannot simply add up the percentages to get a full picture of outcomes, because in many industries courts resolved far fewer disputes of one type than another. For instance, while the percentage of biotechnology-industry patents that were invalidated was higher than the percentage of biotechnology-industry patents held noninfringed, there were actually more findings of noninfringement than invalidity in that industry, simply because there were more motions filed. The same is true of the communications industry.

As for the procedural posture of the cases, our results are not driven by industry differences in trial outcomes or summary judgments of noninfringement; in neither case were our results statistically significant. What are significant are the industry-specific differences in rulings on summary judgment motions on invalidity, as we see in Table 12. While just over 30.0 percent of summary judgment motions on invalidity across our entire data set were granted, win rates vary widely across industries—for example, the energy industry had a motion success rate of 0 percent (none of the 17 motions filed prevailed) while in the biotechnology industry, 56.3 percent of filed invalidity motions prevailed.

82 See, for example, Cotropia and Lemley, 87 NC L Rev at 1456 (cited in note 67) (finding more copying among pharmaceutical patents than patents in other industries).

83 Recall from our previous discussion that there is a biotechnology technology area and also a biotechnology industry category. The latter consists of those biotechnology patents that purported to advance the state of the art in biotechnology research. A substantial majority of the patents from the biotechnology technology area, however, were placed in the medical and pharmaceutical industry categories.

TABLE 12. WIN RATE OF SUMMARY JUDGMENT MOTIONS ON INVALIDITY BY INDUSTRY

SJ Invalidity, All Grounds	Frequency	Percentage	Total
Computer and Other Electronics	15	28.8%	52
Semiconductor	3	27.3%	11
Pharmaceutical	5	17.9%	28
Medical Devices, Methods, and Other Medical	12	25.5%	47
Biotechnology	9	56.3%	16
Communications	24	39.3%	61
Transportation (Including Automotive)	10	40.0%	25
Construction	1	7.7%	13
Energy	0	0.0%	17
Goods and Services for Consumer Uses	19	33.3%	57
Goods and Services for Industrial and Business Uses	33	33.3%	99
Total:	131	30.8%	426

Pearson $\chi^2(10) = 22.2267$; $p = 0.014$

As with technology areas, the grounds for invalidity in our data set differed significantly by industry. While there was no significant difference in rulings based on § 102 prior art, and while the differences in findings of invalidity based on inadequate disclosure (enablement or written description) were significant but modest, findings of obviousness and indefiniteness differed significantly by industry. While less than 30.0 percent of obviousness challenges were successful, the win rate for those arguments ranged from highs of 77.8 percent in construction and 54.2 percent in consumer goods to 0 percent in semiconductors, energy, and biotechnology. The cross industry differences were highly significant ($p = 0.000$), though we note that the small numbers in some of these categories counsel caution in drawing broad conclusions. The fact that the only two biotechnology obviousness challenges failed, for example, does not mean that future challenges always will.

Indefiniteness arguments were primarily successful in the computer and electronics, communications, and industrial-goods industries. In other industries, by contrast (notably pharmaceuticals and energy), indefiniteness arguments never succeeded.

TABLE 13. GROUNDS FOR INVALIDITY BY INDUSTRY

Invalidity, § 102 Prior Art (Any Stage)	Frequency	Percentage	Total
Computer and Other Electronics	11	39.3%	28
Semiconductor	1	14.3%	7
Pharmaceutical	7	17.1%	41
Medical Devices, Methods, and Other Medical	5	20.8%	24
Biotechnology	0	0.0%	2
Communications	13	44.8%	29
Transportation (Including Automotive)	7	50.0%	14
Construction	5	50.0%	10
Energy	2	16.7%	12
Goods and Services for Consumer Uses	8	34.8%	23
Goods and Services for Industrial and Business Uses	13	31.7%	41
Total:	72	31.2%	231

Pearson $\chi^2(10) = 15.4983$; $p = 0.115$

Invalidity, § 103 Obviousness (Any Stage)	Frequency	Percentage	Total
Computer and Other Electronics	7	28.0%	25
Semiconductor	0	0.0%	8
Pharmaceutical	8	14.3%	56
Medical Devices, Methods, and Other Medical	16	44.4%	36
Biotechnology	0	0.0%	2
Communications	8	36.4%	22
Transportation (Including Automotive)	5	33.3%	15
Construction	7	77.8%	9
Energy	0	0.0%	10
Goods and Services for Consumer Uses	13	54.2%	24
Goods and Services for Industrial and Business Uses	8	23.5%	34
Total:	72	29.9%	241

Pearson $\chi^2(10) = 36.5050$; $p = 0.000$

Invalidity, § 112 Inadequate Disclosure (Any Stage)	Frequency	Percentage	Total
Computer and Other Electronics	1	20.0%	5
Semiconductor	1	25.0%	4
Pharmaceutical	7	21.2%	33
Medical Devices, Methods, and Other Medical	3	12.0%	25
Biotechnology	1	50.0%	2
Communications	4	28.6%	14
Transportation (Including Automotive)	1	50.0%	2
Construction	4	100.0%	4
Energy	0	0.0%	12
Goods and Services for Consumer Uses	3	27.3%	11
Goods and Services for Industrial and Business Uses	5	21.7%	23
Total:	30	22.2%	135

Pearson $\chi^2(10) = 24.4367$; $p = 0.007$

As we did with technology areas, we ran multivariate regressions that incorporated the characteristics of patents and lawsuits alongside the industry variables. We present the results in Appendix D. Controlling for patent and lawsuit characteristics, patent owners in the pharmaceutical industry ($p < 0.01$) and the transportation/automotive industry ($p < 0.05$) were significantly more likely to definitively win than in the consumer-goods industry (the omitted variable used as a comparison dummy against which to compare the other industries). Pharmaceutical, transportation/automotive, and construction-industry patents were more likely to be found infringed ($p < 0.01$).

We found similar results when we controlled for districts. We present the results in Appendix E. Compared to patentees in consumer goods, patentees were more likely to win overall in the pharmaceutical ($p < 0.01$) and medical-device, semiconductor, and transportation/automotive ($p < 0.05$) industries. Pharmaceutical, transportation/automotive, and construction-industry patents were more likely to be found infringed ($p < 0.01$) than those in consumer goods. Pharmaceutical, energy, and semiconductor patents were significantly less likely to be held invalid at any stage ($p < 0.05$), as were energy patents ($p < 0.01$), than consumer-goods patents.

Finally, we ran an omnibus regression in which we combined the patent, lawsuit, and district variables along with industry characteristics. In this omnibus specification, we included only three important districts: the Eastern District of Texas, the District of Delaware, and the Northern District of California.[84] We present the results in Appendix F. Not surprisingly, the inclusion of so many variables reduced the significance of some results. Nonetheless, patents in the Eastern District of Texas remained significantly associated with an overall patentee win rate ($p < 0.01$).[85] Pharmaceutical patents were significantly more likely to win overall ($p < 0.01$) than consumer-goods patents (the comparison dummy), as were transportation/automotive and energy patents ($p < 0.05$). Semiconductor and pharmaceutical ($p < 0.05$) and energy ($p < 0.01$) patents were less likely to be held invalid than those in the consumer-goods industry. And pharmaceutical, transportation/automotive, and construction-industry patents were more likely to be infringed ($p < 0.01$) than consumer goods, as were patents covering goods and services for industrial and business uses ($p < 0.05$).

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84 We did not have sufficient degrees of freedom to run a regression including the full set of district dummies.

85 Notably, many judges in the Eastern District of Texas require parties to seek permission before filing a summary judgment motion. See, for example, Sample Docket Control Order for Patent Cases Assigned to Judge Rodney Gilstrap and Judge Roy Payne, *4 (ED Tex, Aug 2014), archived at http://perma.cc/ED9X-GDPV. This practice may artificially reduce the number of summary judgments in the Eastern District of Texas and—because summary judgment grants disproportionately favor defendants compared to jury trials—contribute to the greater patentee win rate in that district. On the other hand, the judges in the Eastern District of Texas might have denied summary judgment motions in these cases even if they had been filed, as denying permission to file may signal a judge's view on the merits of such motions.

In recent work, one of this Article's authors found that filing in the Eastern District of Texas was not a statistically significant predictor of win rate. Mark A. Lemley, Su Li, and Jennifer M. Urban, *Does Familiarity Breed Contempt among Judges Deciding Patent Cases?*, 66 Stan L Rev 1121, 1139–40 (2014). But that study differed from our present one in two respects. First, it included only final determinations made by a judge; it did not include either jury trials or denials of summary judgment motions. Second, it included a different set of control variables, including individual judge fixed effects.

IV. Implications

The outcomes of litigation in our data set vary significantly by both the type of patented technology and the industry in which the parties operate. Across both invalidity and infringement, and regardless of whether we look at industry or technology, chemistry and pharmaceutical patents fare better than virtually any other type of patent. With these notable exceptions, patentees lose the large majority of cases that are litigated to judgment. What can explain these provocative results? In this Part, we leave the comfortable world of hard data for the more exciting, but also more treacherous, world of speculation.

While our data set is limited to litigated patents that reached rulings on summary judgment, trials, or appeals, it is *possible* that these patents are representative of all patents or all litigated patents. To be clear, we have no strong evidence that the patents in our data set are representative of the general population of patents, or even representative of the population of litigated patents that do not result in a final ruling. But if the patents in our data set are indeed representative of all patents, then our results may help explain at a high level the alleged differences in the political and public policy arguments that industries commonly make. Although it is impossible for us to say whether our results are representative of all litigated patents, it is at least possible that they are, and they may be significant to the current policy debate centered on allegations of patent-litigation abuse.

When pharmaceutical and medical-device patent owners insist that patents are strong and valuable, and software companies insist that patents are overclaimed and often invalid, they may both be right.[86] Chemistry and pharmaceutical patents in our data set are significantly more likely to be valid and infringed than software and electronic patents; in the case of software, only one in eight patents ultimately prevails. Somewhat surprisingly, the invalidity rate of software patents is close to that of the average patent that reaches an invalidity ruling.[87] The vast

86 See Benjamin N. Roin, *The Case for Tailoring Patent Awards Based on Time-to-Market*, 61 UCLA L Rev 672, 679–80 (2014) (explaining that software firms "complain that the government grants unnecessary and excessive patent monopolies that adversely affect innovation" and that "pharmaceutical and biotechnology industries widely perceive patents to be critical for protecting their R&D investments").

87 This relatively low invalidity rate may be tied to the relatively high noninfringement rate for software. Courts and litigants may prefer to resolve disputes on noninfringement rather than invalidity. See Ford, 99 Cornell L Rev at 103–12 (cited in note 69).

majority of software patent losses are on noninfringement. Patents in the medical-device and medical-methods industries also do quite well; communications-industry patents do poorly. So if our results are generalizable to all litigated patents, it is understandable that companies in both the computer and communications industries complain about a flood of suits on weak patents while pharmaceutical companies deny that such a problem exists.

And if our results are generalizable to patents more broadly, we might find some comfort in those findings. If we do indeed have a patent system divided by industry and technology, perhaps patent litigation is facilitating that divide. The pharmaceutical and medical-device and medical-methods industries, which in theory rely on strong patent protection, seem to be getting effective protection in the courts. Meanwhile, computer-industry and software-technology patents, which many argue are particularly problematic,[88] overwhelmingly lose in court. Perhaps this is an example of the patent system accommodating industry-specific differences in the desirability of patents, sorting the arguably socially valuable patents from the arguably problematic ones.[89]

There is, however, another possible explanation for our findings: perhaps the patents litigated to summary judgment, trial, or appellate decision are not representative of all patents, or even all litigated patents. In other words, there is a potential selection story. If this explanation is true, then our results are still interesting, although they have less profound implications. In this alternate story, our findings tell us mainly about a subset of all patent litigation. While our findings are from only a small subset of all lawsuits, this subset is nevertheless important

88 See, for example, Lemley, 2013 Wis L Rev at 928 (cited in note 12) (discussing this evidence).

89 The differences that we observe may also reflect variations in the concreteness of patent-law doctrines among technologies. For instance, chemistry patents in our data set were found obvious in only 9.7 percent of decisions and found indefinite in only 3.0 percent. These relatively low rates may support the view that the patent law is stable for inventions in chemistry. Higher rates in other technologies may be due to more legal uncertainty. In these uncertain fields, patent prosecutors may be unsure how to properly claim inventions, and patent litigators may be uncertain how courts will react to claims and prior art. Uncertainty may also encourage more aggressive claiming in both prosecution and litigation, since those broader claims might turn out to be valid. See generally Mark R. Patterson, *Leveraging Information about Patents: Settlements, Portfolios, and Holdups*, 50 Houston L Rev 483 (2012) (explaining that in some patent cases, patentees take advantage of uncertainty regarding their patents).

because there is no feasible way to study the outcomes of cases that were filed but settled before judgment.[90] The lawsuits in our data set require substantial judicial resources, they develop into our body of precedent, and they are presumably considered by other parties when evaluating settlement. More interestingly, the results signify that the filtering of patents through the prosecution, litigation, and licensing systems leaves a small and technologically uneven group of patents that reach judgment. This would mean that the filtering process itself is technology specific, which in itself is interesting.

To put our data set in perspective relative to the universe of patents, it is typically estimated that only a small fraction of issued patents (1 to 2 percent) are ever litigated.[91] An unknown percentage of patents are licensed outside litigation, although we suspect that this percentage is relatively small.[92] Most patents likely expire unlitigated, unlicensed, and uninfringed by others.[93] For those patents involved in litigation, most settle by some mutual agreement between the parties. As we discussed in Part II.C, our data set includes less than 10 percent of the filed lawsuits in the years of our study. And almost half of our data set comprises lawsuits with a summary judgment denial followed by a settlement. Thus, the data set used for the dispositive-rulings analyses may be closer to only 5.0 percent of the filed lawsuits and under 0.1 percent of all patents. Thus, almost nineteen out of

90 We cannot measure outcomes in settled cases because the terms of settlement agreements are almost always confidential. In any event, a settlement does not have a meaningful outcome on a specific issue like definiteness or infringement, reflecting instead the collective judgment of the parties concerning the possible outcomes on the merits and the cost and uncertainty entailed in reaching that decision.

91 See B. Zorina Khan, *Trolls and Other Patent Inventions: Economic History and the Patent Controversy in the Twenty-First Century* *38 (Bowdoin College, Sept 2013), archived at http://perma.cc/4E92-P7VD.

92 See Lemley, 95 Nw U L Rev at 1507 (cited in note 52) (estimating that no more than 5 percent of patents are licensed for a royalty without litigation). Jay Walker, founder of Priceline.com and current chairman of Walker Digital, has recently expressed the view that the patent-licensing system in the United States is broken, leading to litigation in many cases. Dennis Crouch, *Jay Walker: Fix the Licensing System* (Patently-O, July 31, 2014), archived at http://perma.cc/T6VE-PMF6. See also Mark A. Lemley, *Ignoring Patents*, 2008 Mich St L Rev 19, 21–22 (arguing that licensing disputes are often driven to litigation because targets ignore patent claims unless forced to confront them by a lawsuit).

93 See Lemley, 95 Nw U L Rev at 1503 (cited in note 52) (arguing that most expired patents "aren't litigated or licensed during the short time they are in force"); Kimberly A. Moore, *Worthless Patents*, 20 Berkeley Tech L J 1521, 1550–52 (2005) (finding that a large number of patents lapse for failure to pay even a modest maintenance fee, which suggests that they are unlikely to be valuable).

twenty litigated patents and all unlitigated patents are not part of our data set, though we have collected all the cases that resulted in a merits decision.

The law and economics literature on litigation selection effects contends that the cases that are tried—as opposed to settled—are the closest cases. More specifically, George Priest and Benjamin Klein have suggested that tried cases should have a 50 percent plaintiff win rate.[94] Subsequent law and economics literature provides a more nuanced set of factors that affect settlement and adjudication of disputes. This more recent literature argues that deviations from the 50 percent win rate can be caused by a variety of factors, including asymmetric stakes, costs, and risk profiles; agency costs; endowment effects; and other complicating factors.[95] Our results, including the win-rate data from each of summary judgment, trial, and appeal, are inconsistent with the strong Priest-Klein 50 percent hypothesis. The selection stories that we propound below can be viewed as engaging with the law and economics literature that offers factors to explain deviations from the 50 percent win rate. More particularly, we translate these factors into various incentives found in patent litigation, with an emphasis on differences along technology and industry lines. Alternatively, our selection stories may be further evidence that the Priest-Klein 50 percent theory itself is inaccurate.[96]

Turning now to the selection story, if the patents that result in a filed lawsuit differ by industry or technology, this could

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94 George L. Priest and Benjamin Klein, *The Selection of Disputes for Litigation*, 13 J Legal Stud 1, 16–17 (1984). Others have criticized the relevance of the strong Priest-Klein theory to patent litigation. See, for example, Jason Rantanen, *Why Priest-Klein Cannot Apply to Individual Issues in Patent Cases* *3–8 (Mar 21, 2013), archived at http://perma.cc/X994-NSRJ; David L. Schwartz, *Pre-*Markman *Reversal Rates*, 43 Loyola LA L Rev 1073, 1101–07 (2010).

95 See, for example, Kevin M. Clermont, *Litigation Realities Redux*, 84 Notre Dame L Rev 1919, 1951–56 (2009) (discussing the difficulties in measuring outcomes because of the prevalence of settlements); Kevin M. Clermont and Theodore Eisenberg, *Litigation Realities*, 88 Cornell L Rev 119, 137–40 (2002) (discussing the effect of settlement on win rates); Daniel Kessler, Thomas Meites, and Geoffrey Miller, *Explaining Deviations from the Fifty-Percent Rule: A Multimodal Approach to the Selection of Cases for Litigation*, 25 J Legal Stud 233, 237, 242–48 (1996) (considering "seven characteristics of cases that law and economics models predict would affect the plaintiff win rate in litigated cases within the divergent expectations framework").

96 Steve Shavell, for instance, has argued that Priest and Klein are wrong and that any plaintiff win rate is possible. Steven Shavell, *Any Frequency of Plaintiff Victory at Trial Is Possible*, 25 J Legal Stud 493, 494 (1996) (suggesting that it is possible in a simple, frequently employed model of litigation "for the cases that go to trial to result in plaintiff victories with any probability").

partially or fully explain our results. Similarly, if the litigated patents that settle before reaching trial or summary judgment differ by industry or technology, this also could explain our findings. Below we set forth several potential selection stories, which are areas for future research. The stories below are not intended to be an exhaustive list of potential selection stories.

One selection story relates to the particulars of pharmaceutical-industry patent litigation. Generic-drug litigation occurs under the Hatch-Waxman Act,[97] which separates these cases from garden-variety patent infringement litigation. Before filing the lawsuit, the branded-drug patentee has an FDA-granted monopoly.[98] The status quo is no competition, and there can be no direct infringement until the FDA approves the generic drug's application, which in turn usually cannot happen until pending litigation is resolved.[99]

Pharmaceutical-industry patent cases also routinely involve drugs with large market shares, prices, or profits. The costs of litigation to the branded manufacturer typically are small relative to the drug's profits.[100] These facts might push the branded companies to refuse to settle strong cases because they will win anyway. In fact, however, brand owners may have even stronger incentives than other patent owners to settle their cases. Because pharmaceutical patent owners will face no generic competition unless they lose a patent case, they often pay their generic challengers to drop their challenges,[101] in effect splitting the monopoly profits with the generic rather than taking the risk that the patent will be held invalid. Thus, unlike patentees in the other industries, branded-drug companies (the patent owners) sometimes offer to pay a generic in an arrangement commonly known as a "reverse payment." Such reverse-payment settlements were extremely common during the period of our data

97 Drug Price Competition and Patent Term Restoration Act of 1984 ("Hatch-Waxman Act"), Pub L No 98-417, 98 Stat 1585, codified as amended at 21 USC § 301 et seq.

98 See Hemphill and Lemley, 77 Antitrust L J at 962 (cited in note 67) (describing the brand-name firm's monopolistic hold on the market).

99 For a discussion of these rules, see id at 962–65.

100 Several pharmaceutical patent litigators told us that branded manufacturers typically spend more money on litigation in a given case than do generic manufacturers. We have not been able to verify this claim or locate empirical support for it.

101 The Federal Trade Commission collects all such pharmaceutical patent settlements and reports them annually. During the period before *Federal Trade Commission v Actavis, Inc*, 133 S Ct 2223 (2013), there were dozens of such reverse-payment settlements each year. See, for example, Hovenkamp, 1 *IP and Antitrust* at § 15.2c (cited in note 81).

set, though recent antitrust scrutiny may make them less likely in the future.[102]

These different incentives make the direct comparison to "regular" patent litigation difficult. That said, it is not obvious that the selection story explains our results. The willingness of brand owners to use reverse payments to settle disputes might suggest that only particularly weak invalidity challenges (that is, valid patents) go to judgment, because only in those cases is the patentee willing to take a chance on a judicial outcome. But it could suggest the opposite—that generics lured by the promise of a reverse payment will refuse to settle only their strongest challenges.[103] The Abbreviated New Drug Application process itself may encourage weak drug challenges, with little downside risk to the generic beyond paying its own lawyers.[104] The most we can say about the selection story as an explanation for our pharmaceutical-industry results is that patent litigation in the pharmaceutical industry involves a variety of incentives that are distinct from other patent litigation, which may result in a different mix of patents surviving until adjudication.

Unlike pharmaceutical litigation, computer-industry patent litigation (the majority of which involves software patents) is more similar to patent litigation in other technologies. However, there are several potential selection stories that may cause different lawsuits to reach a merits ruling in software as compared to other technologies. The first relates to nonpracticing entities (NPEs)—generally, companies that do not make and sell products—because there are likely more NPE lawsuits in the software field than in the mechanical, chemical, or other technology fields. Using the current data set augmented by data on the types of entities that own the patent, we plan in future work to study how, if at all, the entity status of the patent holder relates to outcomes. The settlement incentives in NPE litigation differ from those in competitor litigation. NPEs have fewer

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102 See *Actavis*, 133 S Ct at 2237 (holding that reverse payments are not presumptively illegal but may still violate the antitrust laws under a rule of reason analysis).

103 A generic that manages to enter before the expiration of a patent, either by settling or by invalidating the patent, is entitled to 180 days of "generic exclusivity" during which no other generic can enter the market. This generic-exclusivity period is often more lucrative to the generic than the entire period of open competition that follows. See Hemphill and Lemley, 77 Antitrust L J at 948 (cited in note 67).

104 See id at 979.

available settlement options than operating companies do.[105] Importantly, they typically cannot settle by means of cross licenses or other business deals. Separately, NPEs are unlikely to be entitled to injunctive relief if they prevail.[106] Both of these affect settlement. Because NPEs are only interested in a monetary payment, they may be more likely to settle cases than companies whose incentives are asymmetric. The evidence that exists is mixed on differences between NPE and non-NPE settlement rates.[107]

Moreover, most NPEs have fewer reputational concerns than operating companies have.[108] One might expect NPEs unconstrained by these concerns to assert weaker patents. But pointing in the other direction is the fact that NPEs' primary assets are patents. It would be extremely bad for business if their patents were adjudicated invalid or not infringed. Their entire revenue stream for that patent could disappear, and they lack a commercial product to profit from. For this reason, some have speculated that NPEs may be more risk averse than similarly situated practicing entities.[109] There are other differences as well, including that the large defendants in the computer-industry cases may have more resources to litigate than smaller plaintiffs, which is the opposite of the resource allocation in pharmaceutical cases. There may be more defendants in the average software case, which likely increases the possibility that at least one accused infringer maintains the case through summary

[105] See Lemley and Melamed, 113 Colum L Rev at 2139–41 (cited in note 55) (describing the ways in which practicing entities differ from NPEs with respect to patent litigation).

[106] See Colleen V. Chien and Mark A. Lemley, *Patent Holdup, the ITC, and the Public Interest*, 98 Cornell L Rev 1, 9–10 (2012) (providing data consistent with the hypothesis that the Supreme Court's decision in *eBay Inc v MercExchange, LLC*, 547 US 388 (2006), made it more difficult for NPEs to obtain injunctive relief).

[107] Compare Allison, Lemley, and Walker, 99 Georgetown L J at 694 (cited in note 42) (finding that, of the most-litigated patents, the NPE settlement rate was not statistically different from the non-NPE settlement rate), with Michael Risch, *A Generation of Patent Litigation: Outcomes and Patent Quality*, 52 San Diego L Rev 67, 69 (2015) (finding that the most litigious NPEs have a higher settlement rate than a matched set of once-litigated patents). Notably, both of these studies oversampled repeat litigants (the focus of these studies) and therefore are not strictly representative of the population as a whole.

[108] See Lemley and Melamed, 113 Colum L Rev at 2165 (cited in note 55) ("It seems likely that practicing entities have in the past been more concerned than trolls about such reputational matters.").

[109] There is conflicting evidence on settlement rates. See, for example, Allison, Lemley, and Walker, 99 Georgetown L J at 694 (cited in note 42); Risch, 52 San Diego L Rev at 77–80 (cited in note 107).

judgment. These differences could affect which software patents reach adjudication.

A second potential selection story relates to the products offered in the computer and electronics industry, which differ from those in some other industries. Products like smartphones involve numerous subcomponents, each of which may be covered by one or more patents. In other industries, particularly in pharmaceuticals, the ratio of patents to products is necessarily much smaller. When the patented invention purportedly covers only a small component of the product, it may be easier to design around it.[110] Designing around the patent, even after litigation has commenced, curtails ongoing damages,[111] which reduces the potential liability and increases the ratio of attorneys' fees to recovery for a patent holder. This may encourage patent holders and accused infringers to settle all cases, as the transaction costs may overwhelm the amount in dispute. Indeed, evidence suggests that some plaintiffs in those industries intentionally aim to obtain a cost-of-litigation defense.[112] Those cases should rationally settle regardless of their merit, making it hard to know how their existence affects selection among software patents.[113] There may be differences in litigation strategies by industry, with patent owners being more willing to take weak cases to judgment in the computer and electronics industry.

A related phenomenon is the rise of contingent fee representation, primarily in the computer and communications industries. The fact that a plaintiff is being represented on a

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110 See *Hilton Davis Chemical Co v Warner-Jenkinson Co*, 62 F3d 1512, 1520 (Fed Cir 1995) (defining "design around" as to use "the patent disclosure to design a product or process that does not infringe, but like the claimed invention, is an improvement over the prior art").

111 See *Westvaco Corp v International Paper Co*, 991 F2d 735, 745 (Fed Cir 1993) (reversing enhanced damages because the defendant had attempted to design around the patented invention).

112 See Colleen Chien, *Patent Assertion Entities* *69 (Santa Clara University, Dec 10, 2012), archived at http://perma.cc/5VYS-DQS9 (reporting that a survey of seventy-eight companies found that in the majority of NPE lawsuits, defined broadly, the legal costs exceed the settlement amount). Lemley and Douglas Melamed refer to such plaintiffs as "bottom feeders." Lemley and Melamed, 113 Colum L Rev at 2127 (cited in note 55). We are not aware of a comparable survey of legal costs and settlement amounts of practicing-entity litigation.

113 If there is a large number of computer and electronics industry lawsuits that both settle for nuisance value and involve weak patents (either likely invalid or not infringed), then our estimates of the patentee success rate may be higher than the success rate of all litigated software patents.

contingent fee basis strongly influences settlement incentives.[114] It also reduces the plaintiff's upfront transaction costs (fees and often expenses) relative to the amount in dispute and relative to the upfront expense the defendant must incur. Settlement strategy is based on a combination of the perceived merits of the case (validity and infringement), damages, and the cost of defense. Contingent fee representation may affect the types of cases that go to judgment. Again, however, it is hard to tell what that effect would be. In theory, contingent fee lawyers may be more likely to seek early settlement, which generates revenue for them with a minimum amount of work, while in theory hourly billing lawyers may be more willing to continue to litigate regardless of the merits or benefits to the client, as that approach generates extra revenue for the lawyers.[115] And the asymmetry between plaintiffs' and defendants' early-stage litigation costs may encourage the bottom-feeder litigation model. These factors certainly have an effect on which cases are selected for final judgment. But again, it is hard to tell what that effect will be. We might expect plaintiffs represented by contingent fee lawyers to bring more (and weaker) cases than other plaintiffs. Or, because the contingent fee lawyers screen cases before accepting to handle them on a contingent basis, the lawsuits they bring may be stronger than other plaintiffs' lawsuits. Plaintiffs represented on a contingent fee basis may be more likely to settle those cases.

Investigating these potential selection stories in great detail is beyond the scope of this Article. Importantly, we do not have the technology and industry classifications for all of the lawsuits from the years 2008 and 2009 that were filed and settled before a dispositive motion or trial. Our data set does, however, include patent-holder interim wins. We recorded a patent-owner interim win when summary judgment was denied and there was no further resolution of the dispute on the merits. These cases included settled cases as well as cases that were still pending as of the time of our coding (summer of 2013). Within patentee interim wins, we also included accused-infringer victories that were vacated and remanded by the Federal Circuit. Although

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114 See David L. Schwartz, *The Rise of Contingent Fee Representation in Patent Litigation*, 64 Ala L Rev 335, 344 (2012) (explaining that, at the very least, contingent fee lawyers are more likely to select cases that are "likely to generate settlements or verdicts that are financially attractive to the lawyers").

115 To be sure, these broad generalizations are tempered by professional-ethics rules that require lawyers to put their clients' interests first.

interim wins do not permit us to fully evaluate the selection stories, they shed light on selection between the patents that reach a summary judgment ruling and those that reach a definitive ruling.

The distribution of interim and dispositive resolutions varies by technology and industry. As shown in Table 14, pharmaceutical patent trials are almost all bench trials, while software, biotechnology, and mechanical technologies are nearly all jury trials. Litigants may view whether a jury or judge will decide the case as a factor in settlement. In pharmaceutical patents, over three-quarters of the definitive winners obtained their victories at trial, as opposed to summary judgment. Biotechnology patents, on the other hand, were conclusively resolved on summary judgment 86.5 percent of the time. And over half of the pharmaceutical trials occurred without the court having previously considered a summary judgment motion. In other words, there was no previous motion to resolve those cases on the papers. The lack of summary judgment rulings may be related to bench trials. Courts might be less willing to consider summary judgment in cases without a jury trial demand. That said, the lack of summary judgment rulings in these cases may affect which cases reach trial. The software, biotechnology, and mechanical procedural dispositions appear quite different.[116]

[116] In Table 14, the total number of trials does not exactly match the number of trials with definitive winners. This is because the results of one software patent trial and three mechanical patent trials were reversed on appeal. If a trial's results were vacated on appeal, we did not include it as a definitive win.

TABLE 14. TRIAL AND DISPOSITION RATES FOR CERTAIN TECHNOLOGIES AND INDUSTRIES

Jury Trials	Frequency	Percentage	Total Trials (Jury and Nonjury)
Pharmaceuticals	3	4.2%	71
Software	63	94.0%	67
Mechanical	74	94.9%	78
Biotechnology	5	100.0%	5

Definitive Rulings at Trial (Not SJ)	Frequency	Percentage	Total Definitive Rulings (Including SJ)
Pharmaceuticals	74	77.9%	95
Software	67	30.0%	223
Mechanical	75	45.2%	166
Biotechnology	4	11.1%	36

Trials without a Prior SJ Ruling	Frequency	Percentage	Total
Pharmaceuticals	42	56.8%	74
Software	19	28.4%	67
Mechanical	22	29.3%	75
Biotechnology	1	20.0%	5

Patentee interim wins differ by technology and industry. Many of these cases involve settlements,[117] which often (though not always) result in money being paid to the patent holder. In Table 15 below, we count patentee interim wins as patentee wins. Of course, if these interim-winner patents had gone to full adjudication, they would not have all prevailed. But using this metric, the win-rate gap shrinks (although not entirely) between pharmaceutical, software, mechanical, and biotechnology patents.

117 Our data do not permit us to cleanly distinguish between those interim wins with a subsequent settlement and those interim wins that are still pending. When originally coding, we did not record whether cases settled, but only whether Lex Machina indicated that cases were still pending at the district court. To give a sense of distribution between likely settlements and pending cases, we note that almost 90 percent of the patentee interim wins in our data set involve cases that have a termination date, per Lex Machina, at the trial court. These likely involve settlements.

TABLE 15. WIN RATES INCLUDING INTERIM WINS AS PATENTEE WINS

Win Rate	Patent Owner Interim Wins	Definitive Patent Owner Wins	Total Wins	Percentage	Total
Pharmaceuticals	14	49	63	57.8%	109
Software	100	30	130	40.2%	323
Mechanical	97	45	142	54.0%	263
Biotechnology	14	2	16	32.0%	50

In sum, patentee interim wins seem to vary by technology and industry. We believe that substantially more work must be completed to understand and assess the selection stories.

Even beyond selection characteristics by technology or industry, there are several other potential concerns. For instance, we cannot rule out the possibility that experienced lawyers are aware of the likelihood of winning on various issues, including the likelihood based on technology or industry. The lawyers may adjust which cases they settle and even which patents they assert, based on their knowledge of win rates at summary judgment and at trial.

The quality of patents may differ substantially by technology and industry. For instance, the pharmaceutical industry may invest more per patent in patent prosecution than other industries. A stronger portfolio of patents may mean that the patents selected from that portfolio for litigation are stronger. Thus, the potential selection stories include not only incentives within the litigation process but also differences that arose in the underlying patents during the prosecution phase.

Separately, we also cannot measure whether the media or general academic discourse influenced any of the judicial rulings. In other contexts, there is evidence that extralegal factors may influence judicial decision making.[118] Software patents have been loudly criticized in the press and by many academics. Judges may be influenced by the dialogue, whether via personal contacts at

[118] See generally Mark A. Lemley and Shawn P. Miller, *If You Can't Beat 'Em, Join 'Em? How Sitting by Designation Affects Judicial Behavior*, 94 Texas L Rev (forthcoming 2015), archived at http://perma.cc/HQZ2-9MS2 (finding that district court judges who sit by designation at the Federal Circuit are reversed less frequently thereafter than other judges).

meetings discussing software patents or indirectly through exposure to newspaper op-eds.

Moving beyond the computer and electronics industry and the pharmaceutical industry, there is one technology and industry that is a startling anomaly: biotechnology. Most of the scholarly discussions about the industry-specific nature of the patent system have placed biotechnology with pharmaceuticals and medical devices as industries that rely heavily on strong patent protection.[119] The economic characteristics of the biotechnology industry bear some similarity to those of the pharmaceutical industry: both require substantial investment over a period of years before bringing a product to market.[120] Scholars have worried that the excessive fragmentation of biotechnology patents will lead to an anticommons problem in which no one can make products because they would have to clear too many rights.[121] But the proposed solutions to the anticommons problem have generally involved consolidating the patent rights in fewer hands, either through broader patents,[122] some sort of specific exemption,[123] or through a patent pool.[124] They have not involved arguing against biotechnology patents altogether.

Our data set suggests that biotechnology companies have been decidedly unsuccessful when they take their patents to judgment, winning only 5.6 percent of their adjudications on both

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119 See, for example, Burk and Lemley, *The Patent Crisis* at 80–81 (cited in note 11); Orton Huang, et al, *Biotechnology Patents and Startups* *2 (2003), archived at http://perma.cc/UA8Z-ACYT ("[P]atents are absolutely essential to the success of traditional biotech startups.").

120 See Burk and Lemley, *The Patent Crisis* at 80–81 (cited in note 11).

121 See, for example, Michael A. Heller and Rebecca S. Eisenberg, *Can Patents Deter Innovation? The Anticommons in Biomedical Research*, 280 Science 698, 698 (1998). For an articulation of the idea of the anticommons, see Michael A. Heller, *The Tragedy of the Anticommons: Property in the Transition from Marx to Markets*, 111 Harv L Rev 621, 624 (1998). For other discussions of the characteristics of biotechnology inventions, see, for example, Arti Kaur Rai, *Regulating Scientific Research: Intellectual Property Rights and the Norms of Science*, 94 Nw U L Rev 77, 130–35 (1999); Rebecca S. Eisenberg, *Proprietary Rights and the Norms of Science in Biotechnology Research*, 97 Yale L J 177, 195–207 (1987).

122 See, for example, Burk and Lemley, *The Patent Crisis* at 151 (cited in note 11) (proposing a "fairly high obviousness threshold coupled with a fairly low disclosure requirement").

123 See, for example, Janice M. Mueller, *No "Dilettante Affair": Rethinking the Experimental Use Exception to Patent Infringement for Biomedical Research Tools*, 76 Wash L Rev 1, 5 & n 23 (2001); Maureen A. O'Rourke, *Toward a Doctrine of Fair Use in Patent Law*, 100 Colum L Rev 1177, 1236–39 (2000).

124 See, for example, Michael A. Carrier, *Resolving the Patent-Antitrust Paradox through Tripartite Innovation*, 56 Vand L Rev 1047, 1105 (2003) ("[C]ross-licenses and patent pools are reasonably necessary to circumvent bottlenecks in the semiconductor and biotechnology industries.").

infringement and validity. Of the litigated patents in our data set, biotechnology patents are much more likely to be invalidated than any other type of patent, and they are less likely than average to be infringed.[125] As a further robustness check, we transformed the unit of analysis for biotechnology from a per-patent analysis to a per-lawsuit analysis. This transformation was intended to evaluate whether biotechnology patent owners were "winning" cases on at least one patent, even if unsuccessful on other patents. Our results on a per-lawsuit basis show a similar trend to the per-patent analysis: three patentee definitive victories, thirteen accused-infringer definitive victories,[126] and six lawsuits that settled with at least one patent still alive.[127] Perhaps selection effects can explain these results too, though the mechanism for such a result is not obvious. It could be that biotechnology companies perform extensive prior-art research before deciding to bring a product to market. After reviewing the prior art, the companies may decide to commercialize in the face of a potential blocking patent only when they possess a strong invalidity or noninfringement defense.

If our results can be generalized to all biotechnology patents, they are both surprising and potentially worrisome. If it is right that biotechnology needs strong patent protection, it appears that it is not receiving it, at least not in the patent-litigation system. Litigation is, of course, only the tip of the iceberg, and it is possible that biotechnology patent owners can comfortably rely on strong licenses to provide them with effective protection even though the patents that reached judgment in our data set were largely unsuccessful. But at the end of the day, the willingness of companies to pay for a patent license is based on the ability of the patentee to credibly threaten to enforce the patent in litigation if the licensee doesn't pay up. If that threat isn't credible, it should be hard for biotechnology patentees to effectively demand licenses

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125 See Tables 3–5 and accompanying text. This is true whether it is a biotechnology-industry patent or biotechnology as a technology that is at issue.

126 For the per-lawsuit analysis, we defined a definitive patentee victory as a lawsuit in which at least one patent was finally adjudicated as valid and infringed. We defined an accused-infringer definitive patentee victory as a lawsuit in which all patents were finally adjudicated as invalid or not infringed.

127 In reviewing our biotechnology results, we noticed that there are two separate lawsuits involving the same parties, the same patents, and the same judge. See generally *Illumina, Inc v Affymetrix, Inc*, 427 Fed Appx 898 (Fed Cir 2011). The court consolidated the lawsuits and ruled on summary judgment in both cases together. We included these as separate observations, and it would lower the number of accused-infringer definitive wins by one if we omitted one of the lawsuits.

outside the litigation system. This disconnect between the observable data and the apparent views of the industry makes us cautious, and we believe further research is needed. For example, we do not know whether the unsuccessful biotechnology patents disproportionately relied upon functional claiming. We also believe that more detailed case studies of biotechnology cases from the years 2008 and 2009[128] or empirical study of additional years of litigation would be fruitful.

As an aside, our data on the biotechnology industry may explain why scholars have had a hard time empirically validating the anticommons theory.[129] There are a lot of patents in the

[128] For those who are interested, the biotechnology cases in our sample from the years 2008 and 2009 are: *Inova Diagnostics, Inc v Euro-Diagnostica AB*, Docket No 3:08-cv-00845 (SD Cal); *Genentech, Inc v Sanofi-Aventis Deutschland GMBH*, Docket No 3:08-cv-04909 (ND Cal); *Billups-Rothenberg, Inc v Associated Regional and University Pathologists, Inc*, Docket No 8:08-cv-01349 (CD Cal); *Central Institute for Experimental Animals v Jackson Laboratory*, Docket No 5:08-cv-05568 (ND Cal); *Medimmune, LLC v PDL BioPharma, Inc*, Docket No 5:08-cv-05590 (ND Cal); *OptiGen, LLC v International Genetics, Inc*, Docket Nos 5:09-cv-0006, 5:09-cv-0457 (NDNY 2011); *Illumina, Inc v Affymetrix, Inc*, Docket No 3:09-cv-00277 (WD Wis); *Monsanto Co v EI DuPont De Nemours and Co*, Docket No 4:09-cv-00686 (ED Mo); *Association For Molecular Pathology v United States Patent and Trademark Office*, Docket No 1:09-cv-04515 (SDNY); *AntiCancer, Inc v Fujifilm Medical Systems USA, Inc*, Docket No 3:09-cv-01311 (SD Cal); *Abbott GmbH & Co, KG v Centocor Ortho Biotech, Inc*, Docket No 4:09-cv-11340 (D Mass); *LadaTech, LLC v Illumina, Inc*, Docket No 1:09-cv-00627 (D Del); *PSN Illinois, LLC v Abbott Laboratories*, Docket No 1:09-cv-05879 (ND Ill); *Gen-Probe, Inc v Becton Dickinson and Co*, Docket No 3:09-cv-02319 (SD Cal); *Sanofi-Aventis Deutschland GMBH v Genentech, Inc*, Docket No 3:09-cv-04919 (ND Cal); *Illumina, Inc v Affymetrix, Inc*, Docket No 3:09-cv-00665 (WD Wis); *Teva Pharmaceuticals USA, Inc v Amgen, Inc*, Docket No 2:09-cv-05675 (ED Penn); *Bayer HealthCare, LLC v Centocor Ortho Biotech Inc*, Docket No 4:09-cv-11362 (D Mass); *Abbott Laboratories v Bayer HealthCare, LLC*, Docket No 4:09-cv-40002 (D Mass); *E8 Pharmaceuticals LLC v Affymetrix, Inc*, Docket No 1:08-cv-11132 (D Mass); *Teva Pharmaceuticals USA, Inc v Sandoz Inc*, Docket No 1:09-cv-10112 (SDNY).

[129] Several scholars have challenged the anticommons story in biotechnology, pointing out that there is little evidence that anticommons problems have actually impeded innovation. See, for example, Christopher M. Holman, *Trends in Human Gene Patent Litigation*, 322 Science 198, 198–99 (2008) ("Human gene patent litigation invariably has involved an accused infringer engaged in substantial commercial activities focused specifically on the single gene that is the subject of the asserted patent, the antithesis of a patent thicket scenario."); John P. Walsh, Charlene Cho, and Wesley M. Cohen, *View from the Bench: Patents and Material Transfers*, 309 Science 2002, 2002–03 (2005) (finding "little empirical basis for claims that restricted access to IP is currently impeding biomedical research"); David E. Adelman, *A Fallacy of the Commons in Biotech Patent Policy*, 20 Berkeley Tech L J 985, 1018 (2005). But see Fiona Murray and Scott Stern, *Do Formal Intellectual Property Rights Hinder the Free Flow of Scientific Knowledge? An Empirical Test of the Anti-commons Hypothesis*, 63 J Econ Behav & Org 648, 651 (2007) (finding that the issuance of a patent reduces citations to the corresponding academic paper, suggesting an anticommons effect); Heidi L. Williams, *Intellectual Property Rights and Innovation: Evidence from the Human Genome* *14–15 (National Bureau of Economic Research Working Paper Series, July 2010), archived at

biotechnology space, and many efforts (especially whole-genome testing) require collection of many different rights. But if researchers simply ignore the existence of those patents, either through ignorance or because they believe they will not lose if sued, they may avoid anticommons problems in practice that should be debilitating in theory.[130]

The biotechnology puzzle calls for further investigation. It may be that the biotechnology industry is suffering from a lack of strong patent protection. If so, that should be evident in the economic and venture capital data if others recognize this shortcoming. Alternatively, it may be that the biotechnology industry is doing just fine, even if patent rights aren't sufficiently strong in the industry. If so, that should cause us to rethink the dominant narrative about the need for strong patents in that industry, and perhaps about the relationship between strong patent enforcement and innovation more generally. After all, biotechnology has been one of the poster children for the argument that strong patents are needed. Finally, it is possible that our data are outliers, and that there is something about the biotechnology patents enforced in the late 2000s that made them systematically weaker than other biotechnology patents. Eight *Myriad* patents, seven of which were invalidated by the Supreme Court, are within our data set and may themselves partially explain the results. Furthermore, the Federal Circuit has tightened the patentability standards for biotechnology patents since 2008.[131] The litigated patents in our data set may have been valid when issued but invalid when adjudicated. Investigating how the biotechnology industry is using patents is beyond the scope of this Article, but our data provide a road map for future work in this area.

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http://perma.cc/FZU9-RH7F (finding that granting intellectual property rights to gene sequences reduced subsequent work using those sequences by 20 to 30 percent).

130 Indeed, the seminal Walsh, Cho, and Cohen paper did not find that there were no significant overlaps in rights but instead found that academic researchers simply paid no attention to those rights. Walsh, Cho, and Cohen, 309 Science at 2002 (cited in note 129). See also Lemley, 2008 Mich St L Rev at 19 (cited in note 92) (finding that inventors and companies ignore the existence of patent rights in industries in which there are too many of those rights).

131 For instance, courts expanded the written description requirement in *Ariad Pharmaceuticals, Inc v Eli Lilly and Co*, 598 F3d 1336 (Fed Cir 2010) (en banc); reduced the patent eligibility of DNA in *Association for Molecular Pathology v Myriad Genetics, Inc*, 133 S Ct 2107 (2013); and increased the likelihood of finding a patent obvious in *In re Kubin*, 561 F3d 1351 (Fed Cir 2009).

Our results are interesting and in some cases quite surprising. Litigation is a complex phenomenon, and some of our results may be due to selection effects. But even if they cannot be generalized, our results suggest that the selection mechanisms for biotechnology- and pharmaceutical-industry patents differ from each other and from electronics patents for unknown reasons. And they are important in their own right for lawyers and clients who bring patent lawsuits.

CONCLUSION

Our patent system is divided. Different technologies and different industries experience the patent system very differently. We find evidence that those differences are present in patent litigation—both in overall outcomes and in the application of specific legal doctrines. Software, communications, and (surprisingly) biotechnology patent owners fare very poorly in court decisions, winning fewer than one in five cases and, in biotechnology, fewer than one in ten cases. These differences are dramatic, and they may have important implications for both patent theory and patent policy.

APPENDIX A. FULL REGRESSION SPECIFICATION BY TECHNOLOGY AREA (PRIMARY PLUS SECONDARY COMBINED), INCLUDING PATENT AND LAWSUIT CHARACTERISTICS (WITHOUT DISTRICTS)

Top row = Coefficient; * = p<0.10, ** = p<0.05, *** = p<0.01; Bottom row = p-value	Patent Owner, Definitive Winner	SJ Invalidity, All	SJ Noninfringement plus Stipulated Jgmt of Noninfringement	Patent Owner, Trial Winner	Invalidity, All (Any Stage)
Foreign Origin of Patent	0.649*** (0.00353)	-0.744** (0.0247)	0.113 (0.650)	0.543* (0.0880)	-1.217*** (1.30e-05)
Adjusted Number of Citations Received	0.132* (0.0658)	-0.149 (0.230)	0.0641 (0.442)	0.0670 (0.583)	0.0757 (0.439)
Total Prior Art References	0.00145* (0.162)	0.000826 (0.555)	-0.00103 (0.235)	0.000988 (0.659)	-0.000866 (0.330)
Number of Claims	0.00970** (0.0333)	-0.00143 (0.845)	0.00175 (0.741)	0.0102* (0.0806)	-0.00732 (0.195)
Age of Patent at Current Litigation Filing	-0.0173 (0.474)	0.0690** (0.0122)	-0.00135 (0.948)	0.0543* (0.0919)	-0.00630 (0.804)
Number of Defendants	0.0170 (0.642)	-0.0510 (0.210)	-0.0153 (0.515)	0.0249 (0.687)	-0.0871* (0.0788)
Number of Asserted Patents	0.0218 (0.320)	-0.0252 (0.264)	-0.0147 (0.437)	0.00157 (0.966)	-0.0177 (0.437)
Mechanical (Primary + Secondary)	-1.019*** (1.09e-05)	0.332 (0.299)	0.0721 (0.755)	-0.382 (0.257)	1.176*** (2.27e-05)
Eletrical (Primary + Secondary)	-0.700 (0.201)	-0.431 (0.261)	-0.110 (0.718)	-0.940 (0.149)	-0.508 (0.204)
Biotechnology (Primary + Secondary)	-2.888*** (1.25e-05)	1.118* (0.0635)	0.481 (0.262)	-0.874 (0.420)	2.456*** (0.00214)
Optics (Primary + Secondary)	-0.415 (0.397)	-0.970 (0.166)	0.0379 (0.917)	0.153 (0.855)	0.252 (0.606)
Software (Primary + Secondary)	-1.906*** (0)	0.860*** (0.00744)	0.0641 (0.796)	-0.296 (0.392)	0.895*** (0.00180)
Comparison Dummy = Chemistry					
F-Test for Joint Technology Effects	70.71*** (0)	11.07** (0.0500)	1.482 (0.915)	4.786 (0.443)	23.73*** (0.000245)
Observations	632	427	506	288	440

Top row = Coefficient; * = *p*<0.10, ** = *p*<0.05, *** = *p*<0.01; Bottom row = *p*-value	Invalidity, § 102 Prior Art, All (Any Stage)	Invalidity, § 103 Obviousness (Any Stage)	Invalidity, § 112 Indefiniteness (Any Stage)	Invalidity, § 112 Inadequate Disclosure (Any Stage)	Direct Infringe-ment, Literal plus DOE (Any Stage)
Foreign Origin of Patent	-0.894 (0.163)	-1.177** (0.0382)	-1.223 (0.179)	-0.663 (0.671)	0.495** (0.0276)
Adjusted Number of Citations Received	0.117 (0.427)	0.0233 (0.892)	-0.248 (0.356)	0.390 (0.472)	0.0592 (0.507)
Total Prior Art References	0.000667 (0.710)	-0.00124 (0.628)	-0.00556 (0.547)	-0.00942 (0.470)	0.00495*** (0.00173)
Number of Claims	-0.0135 (0.139)	-0.00284 (0.751)	-0.0158 (0.403)	-0.0347 (0.321)	0.00555 (0.260)
Age of Patent at Current Litigation Filing	0.00850 (0.855)	-0.0527 (0.254)	0.0228 (0.719)	0.0481 (0.653)	-0.0282 (0.239)
Number of Defendants	-0.116 (0.311)	-0.0238 (0.756)	-0.251* (0.0649)	-0.127 (0.268)	0.00903 (0.777)
Number of Asserted Patents	-0.0290 (0.606)	0.0359 (0.567)	-0.0471 (0.578)	0.0391 (0.807)	-0.0117 (0.665)
Mechanical (Primary + Secondary)	1.328*** (0.00289)	1.809*** (0.000218)	0.455 (0.857)	1.336 (0.151)	-0.366 (0.134)
Eletrical (Primary + Secondary)	-1.242* (0.0881)	0.127 (0.925)	1.020 (0.221)	0.473 (0.811)	-1.062** (0.0272)
Biotechnology (Primary + Secondary)	1.195 (0.336)	2.039* (0.0946)		5.217** (0.0492)	-0.421 (0.452)
Optics (Primary + Secondary)	0.00590 (0.994)	0.935 (0.509)	0.429 (0.693)		-1.128* (0.0744)
Software (Primary + Secondary)	1.467*** (0.00121)	0.764 (0.211)	0.975 (0.694)	0.895 (0.365)	-1.368*** (1.10e-06)
Comparison Dummy = Chemistry					
F-Test for Joint Technology Effects	15.08*** (0.0100)	16.43*** (0.00572)	3.002 (0.558)	4.415 (0.353)	36.37*** (8.02e-07)
Observations	229	239	171	118	542

APPENDIX B. REGRESSION SPECIFICATION BY TECHNOLOGY AREA (PRIMARY ONLY), INCLUDING DISTRICTS (WITHOUT PATENT AND LITIGATION CHARACTERISTICS)

Top row = Coefficient; * = $p<0.10$, ** = $p<0.05$, *** = $p<0.01$; Bottom row = p-value	Patent Owner, Definitive Winner	SJ Invalidity, All	SJ Noninfringement plus Stip Jgmt of Noninfringement	Patent Owner, Trial Winner	Invalidity, All (Any Stage)
ED Tex	1.516*** (4.34e-06)	-1.336*** (0.00309)	-0.662* (0.0546)	0.175 (0.718)	-1.429*** (0.000217)
D Del	0.291 (0.377)	-0.815* (0.0856)	0.276 (0.391)	-1.038* (0.0531)	-0.234 (0.534)
ND Cal	0.0887 (0.836)	-0.130 (0.765)	0.113 (0.796)	-1.112 (0.115)	0.608 (0.147)
CD Cal	-1.279** (0.0364)	0.547 (0.317)	0.136 (0.744)	0.181 (0.848)	0.265 (0.630)
SD Cal	-0.0137 (0.982)	-1.337* (0.0889)	-0.246 (0.612)	-0.606 (0.441)	0.0473 (0.947)
SDNY	1.766*** (0.000161)	-0.589 (0.298)	0.0908 (0.880)		-1.549 (0.590)
ND Ill	-1.202** (0.0171)	0.665 (0.311)	-0.773* (0.0794)	-2.054** (0.0208)	-0.0884 (0.885)
WD Wis	0.955** (0.0494)	-1.064* (0.0833)	0.637 (0.315)	1.299* (0.0516)	-1.832*** (0.00138)
D NJ	-0.919 (0.159)	0.359 (0.581)	-0.0634 (0.928)	-1.976** (0.0301)	0.962 (0.154)
D Mass		-1.574** (0.0260)	-0.321 (0.613)		0.250 (0.758)
ED Va	0.584 (0.402)	-1.409** (0.0488)	0.178 (0.746)	-0.949 (0.279)	0.102 (0.912)
ND Ohio	0.137 (0.865)			-0.655 (0.403)	-2.666*** (2.98e-05)
SD Tex	1.209** (0.0314)	-1.963*** (0.00649)	1.949*** (0.000846)	-0.218 (0.758)	-1.563** (0.0189)
Mechanical (Primary)	-0.860*** (0.00571)	0.504 (0.296)	-0.0305 (0.936)	-0.460 (0.298)	1.213*** (0.00218)
Electrical (Primary)	-0.714* (0.0590)	0.519 (0.350)	0.185 (0.662)	0.313 (0.507)	0.500 (0.267)
Biotechnology (Primary)	-3.225*** (4.53e-05)	1.683** (0.0117)	0.521 (0.354)		3.097 (0.322)
Optics (Primary)	-1.680*** (0.00123)	-0.448 (0.570)	-0.278 (0.660)	-0.638 (0.326)	-0.148 (0.847)
Software (Primary)	-2.033*** (1.13e-09)	1.080** (0.0176)	0.257 (0.486)	-0.523 (0.294)	1.087*** (0.00455)
Comparison Dummy = Chemistry					
F-Test for Joint Technology Effects	56.67*** (5.93e-11)	13.05** (0.0229)	2.723 (0.743)	2.930 (0.570)	14.30** (0.0138)
Observations	616	418	498	259	440

Top row = Coefficient; * = *p*<0.10, ** = *p*<0.05, *** = *p*<0.01; Bottom row = *p*-value	Invalidity, § 102 Prior Art, All (Any Stage)	Invalidity, § 103 Obviousness (Any Stage)	Invalidity, § 112 Indefiniteness (Any Stage)	Invalidity, § 112 Inadequate Disclosure (Any Stage)	Direct Infringement, Literal plus DOE (Any Stage)
ED Tex	-1.537** (0.0201)	-0.499 (0.422)	-1.686** (0.0398)		0.911*** (0.00498)
D Del	-0.673 (0.259)	-0.503 (0.349)	0.0249 (0.998)	2.683 (0.897)	-0.0482 (0.891)
ND Cal	0.465 (0.532)	0.819 (0.765)	-0.134 (0.856)	1.755 (0.925)	-1.266** (0.0307)
CD Cal	1.035 (0.286)	0.271 (0.856)	0.597 (0.455)		-1.147* (0.0879)
SD Cal	0.389 (0.602)	0.983 (0.310)		3.537 (0.849)	0.347 (0.454)
SDNY	-0.659 (0.478)				1.342* (0.0530)
ND Ill	1.164 (0.214)	1.118 (0.613)	-0.711 (0.227)	4.065 (0.842)	-0.192 (0.742)
WD Wis		-1.433** (0.0266)			-0.240 (0.684)
D NJ	-1.083 (0.213)	0.802 (0.852)		5.223 (0.797)	-1.411* (0.0647)
D Mass	0.356 (0.748)	2.454** (0.0110)		3.343 (0.848)	-0.471 (0.547)
ED Va	-1.028 (0.219)	-0.855 (0.306)	-0.422 (0.159)		-0.188 (0.758)
ND Ohio					-0.910 (0.249)
SD Tex	-1.006 (0.240)		-2.214*** (0.000274)		1.050* (0.0534)
Mechanical (Primary)	0.623 (0.332)	1.851 (0.663)		0.723 (0.755)	-0.815** (0.0238)
Electrical (Primary)	-0.796 (0.386)	0.601 (0.904)	2.629 (0.820)	-0.217 (0.955)	-1.369*** (0.00288)
Biotechnology (Primary)	-0.287 (0.766)	0.607 (0.887)		2.578 (0.832)	-1.069* (0.0841)
Optics (Primary)	-0.639 (0.590)		1.310 (0.915)		-2.602*** (2.30e-05)
Software (Primary)	0.821 (0.159)	1.200 (0.776)	2.031 (0.869)	1.743 (0.583)	-2.173*** (9.75e-10)
Comparison Dummy = Chemistry					
F-Test for Joint Technology Effects	8.306 (0.140)	3.575 (0.467)	8.099** (0.0440)	1.529 (0.676)	55.12*** (1.23e-10)
Observations	219	204	118	81	542

APPENDIX C. REGRESSION SPECIFICATION BY TECHNOLOGY (PRIMARY ONLY) WITH TRUNCATED DISTRICT DUMMIES, WITHOUT PATENT AND LITIGATION CHARACTERISTICS, AND WITH SOFTWARE SEPARATED INTO BUSINESS METHODS AND NON–BUSINESS METHODS

Top row = Coefficient; * = p<0.10, ** = p<0.05, *** = p<0.01; Bottom row = Std error	Patent Owner, Definitive Winner	SJ Invalidity, All	SJ Noninfringement plus Stip Jgmt of Noninfringement	Patent Owner, Trial Winner	Invalidity, All (Any Stage)
Foreign Origin of Patent	0.601** (0.0230)	-0.772* (0.0796)	0.152 (0.584)	0.541 (0.287)	-1.246*** (0.000303)
Adjusted Number of Citations Received	0.0932 (0.270)	-0.160 (0.274)	0.0394 (0.649)	0.0387 (0.752)	0.0754 (0.488)
Total Prior Art References	0.00171* (0.0532)	0.00107 (0.430)	-0.000758 (0.404)	0.00161 (0.363)	-0.00138 (0.209)
Number of Claims	0.00950* (0.0563)	-0.00423 (0.603)	0.00283 (0.624)	0.0174*** (0.00427)	-0.00737 (0.216)
Age of Patent at Current Litigation Filing	-0.0313 (0.202)	0.0970*** (0.00515)	0.00358 (0.874)	0.0460 (0.355)	0.00529 (0.859)
Number of Defendants	0.0518 (0.221)	-0.0637 (0.245)	-0.00755 (0.786)	-0.00370 (0.978)	-0.103* (0.0813)
Number of Asserted Patents	0.00525 (0.826)	-0.0112 (0.671)	-0.00963 (0.662)	-0.0216 (0.656)	0.0459 (0.158)
ED Tex	1.336*** (0.000149)	-1.226** (0.0253)	-0.663* (0.0783)	0.0630 (0.911)	-1.715*** (0.000226)
D Del	0.144 (0.690)	-0.714 (0.220)	0.269 (0.419)	-1.119** (0.0420)	-0.190 (0.675)
ND Cal	0.0410 (0.922)	0.00240 (0.996)	0.110 (0.797)	-1.089 (0.118)	0.476 (0.295)
Mechanical (Primary)	-0.863*** (0.00300)	0.505 (0.338)	-0.0317 (0.935)	-0.537 (0.247)	1.266*** (0.00263)
Electrical (Primary)	-0.851** (0.0239)	0.618 (0.342)	0.191 (0.666)	0.350 (0.653)	0.380 (0.463)
Biotechnology (Primary)	-3.444*** (4.99e-05)	1.635** (0.0310)	0.564 (0.295)		2.610 (0.359)
Software BM (Subset of Primary)	-2.307*** (0.000109)	1.789*** (0.00779)	0.468 (0.422)	-0.198 (0.796)	1.609** (0.0140)
Software NBM (Subset of Primary)	-2.176*** (2.20e-09)	1.045* (0.0575)	0.248 (0.524)	-0.449 (0.476)	0.942* (0.0682)
Optics (Primary)	-1.490** (0.0156)	-0.721 (0.389)	-0.264 (0.676)	0.0685 (0.954)	-0.375 (0.692)
Comparison Dummy = Chemistry					
F-Test for Joint Technology Effects	53.34*** (0.000000001)	15.64** (0.0158)	3.358 (0.763)	3.861 (0.57)	17.19*** (0.0086)
Observations	616	418	498	259	440

Top row = Coefficient; * = *p*<0.10, ** = *p*<0.05, *** = *p*<0.01; Bottom row = Std error	Invalidity, § 102 Prior Art, All (Any Stage)	Invalidity, § 103 Obviousness (Any Stage)	Invalidity, § 112 Indefinite-ness (Any Stage)	Invalidity, § 112 Inadequate Disclosure (Any Stage)	Direct Infringement, Literal plus DOE (Any Stage)
Foreign Origin of Patent	-1.108 (0.187)	-1.496*** (0.00730)	-0.821 (0.679)	-0.216 (0.829)	0.246 (0.338)
Adjusted Number of Citations Received	0.137 (0.458)	-0.0573 (0.811)	-0.390 (0.264)	0.661 (0.210)	0.0616 (0.499)
Total Prior Art References	0.00131 (0.611)	-0.00148 (0.548)	-0.000733 (0.945)	-0.0169 (0.106)	0.00279** (0.0227)
Number of Claims	-0.0124 (0.312)	0.000685 (0.956)	-0.00959 (0.873)	-0.0636 (0.253)	0.00626 (0.179)
Age of Patent at Current Litigation Filing	0.0717 (0.301)	-0.0133 (0.786)	0.144 (0.677)	-0.0886 (0.458)	-0.0474* (0.0780)
Number of Defendants	-0.197 (0.274)	-0.0614 (0.556)	-0.0914 (0.557)	-0.442* (0.0557)	0.0181 (0.642)
Number of Asserted Patents	0.0701 (0.426)	0.136** (0.0263)	-0.0846 (0.647)	0.289* (0.0828)	0.00356 (0.901)
ED Tex	-2.115** (0.0267)	-0.840 (0.400)	-1.284 (0.492)		0.633* (0.0765)
D Del	-0.828 (0.269)	-0.259 (0.702)	0.493 (0.955)	2.184 (0.229)	-0.181 (0.618)
ND Cal	0.332 (0.735)	0.810 (0.440)	0.170 (0.951)	1.486 (0.422)	-1.365** (0.0177)
Mechanical (Primary)	0.588 (0.485)	2.248 (0.607)		1.207 (0.300)	-0.794** (0.0453)
Electrical (Primary)	-0.896 (0.467)	0.340 (0.940)	4.299 (0.782)	-0.839 (0.673)	-1.613*** (0.00164)
Biotechnology (Primary)	-0.488 (0.792)	0.528 (0.909)		11.75 (0.759)	-1.288* (0.0680)
Software BM (Subset of Primary)	1.129 (0.313)	0.583 (0.895)	4.355 (0.759)		-2.140*** (0.000668)
Software NBM (Subset of Primary)	0.839 (0.350)	1.250 (0.770)	2.767 (0.854)	1.361 (0.491)	-2.239*** (4.60e-08)
Optics (Primary)	-0.949 (0.503)		1.970 (0.890)		-2.593*** (0.000290)
Comparison Dummy = Chemistry					
F-Test for Joint Technology Effects	6.814 (0.338)	7.165 (0.209)	1.594 (0.810)	3.618 (0.460)	43.88*** (7.80e-08)
Observations	219	204	118	79	542

APPENDIX D. FULL REGRESSION SPECIFICATION BY INDUSTRY, INCLUDING PATENT AND LAWSUIT CHARACTERISTICS (WITHOUT DISTRICTS)

Top row = Coefficient; * = p<0.10, ** = p<0.05, *** = p<0.01; Bottom row = p-value	Patent Owner, Definitive Winner	SJ Invalidity, All	SJ Noninfringement plus Stip Jgmt of Noninfringement	Patent Owner, Trial Winner	Invalidity, All (Any Stage)
Foreign Origin of Patent	0.693*** (0.00194)	-0.694** (0.0473)	0.0501 (0.847)	0.606* (0.0810)	-1.206*** (8.56e-05)
Adjusted Number of Citations Received	0.120 (0.160)	-0.0578 (0.615)	0.0639 (0.459)	0.116 (0.449)	0.0902 (0.323)
Total Prior Art References	0.00131 (0.219)	5.41e-05 (0.971)	-0.000833 (0.283)	0.00141 (0.663)	-0.000882 (0.338)
Number of Claims	0.00561 (0.230)	0.000674 (0.913)	0.00207 (0.714)	0.0105* (0.0884)	-0.00547 (0.272)
Age of Patent at Current Litigation Filing	-0.0179 (0.454)	0.0512* (0.0589)	0.00454 (0.836)	0.0500 (0.189)	-0.00621 (0.815)
Number of Defendants	0.0159 (0.645)	-0.0552 (0.269)	-0.0214 (0.398)	0.0277 (0.745)	-0.114* (0.0555)
Number of Asserted Patents	0.0258 (0.254)	-0.0234 (0.268)	-0.00955 (0.634)	0.0124 (0.805)	-0.0174 (0.495)
Computer and Other Electronics	0.213 (0.647)	-0.346 (0.468)	-0.422 (0.265)	0.216 (0.844)	-0.370 (0.458)
Semiconductor	0.994 (0.147)	-0.522 (0.483)	-0.362 (0.560)	1.340 (0.277)	-1.758** (0.0122)
Pharmaceutical	1.771*** (2.17e-05)	-0.596 (0.383)	0.0782 (0.849)	-0.0724 (0.944)	-0.932** (0.0335)
Medical Devices, Methods, and Other Medical	0.822* (0.0728)	-0.431 (0.362)	0.0164 (0.969)	-0.673 (0.522)	0.205 (0.637)
Biotechnology (Industry)	-0.506 (0.486)	0.683 (0.310)	-0.297 (0.567)		1.053 (0.224)
Communication	-0.250 (0.618)	0.299 (0.452)	-0.321 (0.367)	-0.846 (0.426)	-0.125 (0.768)
Transportation (Including Automotive)	1.264** (0.0153)	0.0406 (0.944)	-0.268 (0.654)	1.604 (0.171)	0.137 (0.823)
Construction	0.352 (0.632)	-1.872*** (0.00462)	0.0602 (0.921)	-0.794 (0.541)	1.006 (0.181)
Energy	1.081** (0.0291)		0.0465 (0.948)	0.673 (0.549)	-1.885*** (0.00139)
Goods and Services for Industrial and Business Uses	0.527 (0.208)	-0.0179 (0.963)	-0.152 (0.645)	0.181 (0.862)	-0.127 (0.751)
Comparison Dummy = Consumer Goods and Services					
F-Test for Joint Technology Effects	44.77*** (2.39e-06)	14.55 (0.104)	2.849 (0.985)	19.09** (0.0245)	33.26*** (0.000246)
Observations	632	410	506	286	440

Top row = Coefficient; * = p<0.10, ** = p<0.05, *** = p<0.01; Bottom row = p-value	Invalidity, § 102 Prior Art, All (Any Stage)	Invalidity, § 103 Obviousness (Any Stage)	Invalidity, § 112 Indefiniteness (Any Stage)	Invalidity, § 112 Inadequate Disclosure (Any Stage)	Direct Infringement, Literal plus DOE (Any Stage)
Foreign Origin of Patent	-0.784 (0.291)	-0.994* (0.0523)	-0.116 (0.889)	-0.203*** (0.00775)	0.629*** (0.00646)
Adjusted Number of Citations Received	0.170 (0.235)	-0.0617 (0.764)	-0.231 (0.531)	0.391* (0.0820)	0.162* (0.0801)
Total Prior Art References	0.000266 (0.896)	-0.00247 (0.381)	-0.00412 (0.307)	-0.00978*** (0)	0.00387*** (0.00370)
Number of Claims	-0.0104 (0.249)	0.00702 (0.495)	-0.00258 (0.919)	0.00974*** (4.75e-07)	0.00467 (0.359)
Age of Patent at Current Litigation Filing	0.0214 (0.647)	-0.0277 (0.512)	0.0484 (0.385)	0.0552*** (0.00507)	-0.0312 (0.249)
Number of Defendants	-0.174 (0.299)	-0.0801 (0.531)	-0.123 (0.291)	-0.192 (0.242)	-0.00246 (0.945)
Number of Asserted Patents	-0.0182 (0.778)	0.0649 (0.392)	-0.0239 (0.740)	0.107** (0.0147)	0.00538 (0.846)
Computer and Other Electronics	-0.444 (0.614)	-1.556* (0.0738)	1.663 (0.760)	-2.272 (0.206)	0.432 (0.308)
Semiconductor	-1.937** (0.0331)		2.462 (0.657)	-0.277 (0.906)	0.359 (0.605)
Pharmaceutical	-1.259* (0.0963)	-1.659** (0.0177)		-0.530 (0.623)	2.146*** (3.35e-07)
Medical Devices, Methods, and Other Medical	-1.069 (0.231)	-0.141 (0.840)	1.310 (0.821)	-1.930** (0.0474)	0.297 (0.529)
Biotechnology (Industry)				3.916** (0.0279)	0.822 (0.217)
Communication	0.147 (0.846)	-0.788 (0.325)	0.926 (0.870)	-0.722 (0.714)	-0.737 (0.142)
Transportation (Including Automotive)	0.116 (0.909)	-0.853 (0.255)		1.323 (0.398)	1.718*** (0.00243)
Construction	0.254 (0.799)	0.841 (0.385)			1.875*** (0.000428)
Energy	-1.149 (0.201)				1.112* (0.0859)
Goods and Services for Industrial and Business Uses	-0.423 (0.557)	-1.372* (0.0565)	1.033 (0.859)	-0.698** (0.0251)	0.976** (0.0134)
Comparison Dummy = Consumer Goods and Services					
F-Test for Joint Technology Effects	14.36 (0.110)	16.44** (0.0214)	4.756 (0.446)	0.0140 (0.906)	61.63*** (1.78e-09)
Observations	227	219	132	118	542

APPENDIX E. FULL INDUSTRY SPECIFICATION WITH ALL DISTRICTS

Top row = Coefficient; * = *p*<0.10, ** = *p*<0.05, *** = *p*<0.01; Bottom row = *p*-value	Patent Owner, Definitive Winner	SJ Invalidity, All	SJ Noninfringement plus Stip Jgmt of Noninfringement	Patent Owner, Trial Winner	Invalidity, All (Any Stage)
Foreign Origin of Patent	0.621** (0.0295)	-0.781 (0.105)	0.0787 (0.783)	0.286 (0.459)	-1.268*** (0.000887)
Adjusted Number of Citations Received	0.0475 (0.551)	-0.0566 (0.677)	0.0527 (0.516)	0.0864 (0.468)	0.121 (0.280)
Total Prior Art References	0.00172* (0.0820)	0.000481 (0.774)	-0.000662 (0.510)	0.00303* * (0.0291)	-0.00164 (0.120)
Number of Claims	0.00714 (0.130)	0.000374 (0.965)	0.00399 (0.519)	0.0170** (0.0332)	-0.00417 (0.448)
Age of Patent at Current Litigation Filing	-0.0228 (0.432)	0.0670* (0.0752)	0.00641 (0.809)	0.0352 (0.369)	-0.0113 (0.718)
Number of Defendants	0.0449 (0.165)	-0.0338 (0.598)	-0.0118 (0.594)	0.0385 (0.632)	-0.103 (0.180)
Number of Asserted Patents	0.00380 (0.860)	-0.0215 (0.456)	-0.00433 (0.849)	-0.0247 (0.509)	0.0227 (0.516)
ED Tex	1.336*** (9.71e-05)	-1.168** (0.0303)	-0.422 (0.218)	-0.305 (0.589)	-1.333*** (0.00238)
D Del	0.194 (0.673)	-0.848 (0.192)	0.227 (0.596)	-1.655*** (0.00382)	0.213 (0.646)
ND Cal	-0.380 (0.465)	0.106 (0.864)	0.289 (0.526)	-0.227 (0.731)	0.558 (0.272)
CD Cal	-1.462** (0.0299)	0.898 (0.159)	0.378 (0.445)	-2.263 (0.325)	1.127 (0.132)
SD Cal	-0.267 (0.642)	-1.433 (0.108)	-0.105 (0.852)	-0.381 (0.717)	0.124 (0.909)
SDNY	1.043 (0.144)	-0.456 (0.462)	0.294 (0.636)		-1.141 (0.715)
ND Ill	-1.700** (0.0244)	0.620 (0.483)	-0.449 (0.343)	-5.261*** (0.00861)	0.866 (0.214)
WD Wis	1.154** (0.0486)	-1.580*** (0.00534)	0.748 (0.322)	0.917 (0.473)	-2.116*** (0.00222)
D NJ	-1.071 (0.170)	0.557 (0.533)	-0.133 (0.877)	-2.595*** (0.00398)	1.515** (0.0219)
D Mass		-1.613* (0.0525)	-0.238 (0.659)		0.949 (0.366)
ED Va	0.709 (0.266)	-1.630** (0.0163)	0.265 (0.552)	-1.571** (0.0371)	0.206 (0.809)
ND Ohio	0.371 (0.547)			-2.474 (0.178)	-1.995*** (0.00118)
SD Tex	0.0438 (0.995)	-0.144 (0.880)	3.178 (0.638)	-14.91 (0.986)	14.29*** (0)
Computer and Other Electronics	0.139 (0.796)	-0.114 (0.841)	-0.349 (0.366)	1.355 (0.109)	-0.394 (0.474)
Semiconductor	1.598** (0.0405)	-0.439 (0.723)	-0.449 (0.506)	4.011* (0.0555)	-2.652** (0.0165)
Pharmaceutical	1.799*** (0.00160)	-0.756 (0.376)	0.0389 (0.946)	1.418* (0.0896)	-1.287** (0.0289)

Medical Devices, Methods, and Other Medical	1.281** (0.0114)	-0.198 (0.753)	0.0876 (0.858)	-0.145 (0.860)	-0.205 (0.722)
Biotechnology (Industry)	-0.607 (0.528)	0.966 (0.287)	-0.356 (0.581)		1.421 (0.683)
Communication	-0.220 (0.668)	0.817 (0.155)	-0.0937 (0.817)	0.539 (0.512)	-0.209 (0.713)
Transportation (Including Automotive)	1.332** (0.0126)	0.564 (0.413)	-0.205 (0.699)	3.464** (0.0119)	0.278 (0.693)
Construction	0.548 (0.493)	-1.995*** (0.00761)	0.168 (0.768)	-0.353 (0.790)	0.736 (0.479)
Energy	1.311 (0.849)		-1.512 (0.825)	15.87 (0.985)	-16.30*** (0)
Goods and Services for Industrial and Business Uses	0.440 (0.283)	0.00533 (0.991)	-0.0740 (0.835)	1.608** (0.0398)	-0.313 (0.502)
Comparison Dummy = Consumer Goods and Services					
F-Test for Joint Technology Effects	30.11*** (0.000821)	17.68** (0.0391)	3.085 (0.979)	18.51** (0.0297)	230.1*** (0)
Observations	616	401	498	259	440

Top row = Coefficient; * = p<0.10, ** = p<0.05, *** = p<0.01; Bottom row = p-value	Invalidity, § 102 Prior Art, All (Any Stage)	Invalidity, § 103 Obviousness (Any Stage)	Invalidity, § 112 Indefinite-ness (Any Stage)	Invalidity, § 112 Inadequate Disclosure (Any Stage)	Direct Infringement, Literal plus DOE (Any Stage)
Foreign Origin of Patent	-0.995 (0.278)	-1.222** (0.0294)	0.292 (0.728)	2.051 (0.131)	0.603*** (0.00296)
Adjusted Number of Citations Received	0.208 (0.248)	-0.0163 (0.927)	-0.226 (0.387)	0.297 (0.425)	0.128 (0.192)
Total Prior Art References	0.000347 (0.901)	-0.00161 (0.621)	-0.00444 (0.421)	-0.00821 (0.401)	0.00319*** (0.00971)
Number of Claims	-0.00982 (0.412)	0.00592 (0.622)	0.00137 (0.916)	0.0140 (0.617)	0.00595 (0.256)
Age of Patent at Current Litigation Filing	0.0617 (0.549)	0.0133 (0.756)	0.0787 (0.297)	0.0383 (0.715)	-0.0394 (0.170)
Number of Defendants	-0.244 (0.395)	-0.122 (0.510)	-0.00718 (0.958)	0.0625 (0.718)	-0.000278 (0.992)
Number of Asserted Patents	0.0440 (0.650)	0.0967 (0.333)	-0.0300 (0.621)	0.187 (0.201)	0.00191 (0.919)
ED Tex	-1.851 (0.218)	-0.955 (0.492)	-1.058 (0.180)		0.470 (0.312)
D Del	-0.363 (0.697)	0.0469 (0.950)	-0.691 (0.601)	0.656 (0.697)	-0.318 (0.484)
ND Cal	0.403 (0.678)	-0.116 (0.880)	0.117 (0.910)	0.773 (0.668)	-1.610*** (0.00796)
CD Cal	1.336 (0.328)		1.480 (0.333)		-1.297 (0.132)
SD Cal	0.735 (0.181)	1.389 (0.227)			0.0969 (0.798)
SDNY	-1.542 (0.291)				0.577 (0.554)
ND Ill	1.257 (0.337)	0.733 (0.465)	-0.764 (0.562)	2.888 (0.188)	-0.149 (0.840)
WD Wis		-1.334* (0.0720)			-0.0807 (0.890)
D NJ	0.0320 (0.982)	1.417 (0.137)		3.881* (0.0706)	-1.888 (0.113)
D Mass	0.799 (0.425)	1.915 (0.137)		2.282 (0.159)	-0.402 (0.530)
ED Va	-1.486 (0.106)	-1.055 (0.351)	0.131 (0.900)		-0.204 (0.774)
ND Ohio					-0.732 (0.237)
SD Tex	13.58*** (0.000170)				0.933 (0.230)
Computer and Other Electronics	-0.749 (0.529)	-1.623 (0.161)	1.921* (0.0592)	-1.738 (0.558)	0.581* (0.0904)
Semiconductor	-3.235*** (0.00634)			2.294 (0.430)	0.976 (0.148)
Pharmaceutical	-1.656 (0.352)	-2.072* (0.0630)		0.622 (0.751)	2.346*** (0.00380)
Medical Devices, Methods, and Other Medical	-2.093* (0.0999)	-0.498 (0.363)	0.00687 (0.997)	-1.930 (0.405)	0.630 (0.281)

Biotechnology (Industry)					1.194 (0.299)
Communication	-0.247 (0.810)	-0.954 (0.235)	0.825 (0.427)	1.042 (0.687)	-0.618 (0.174)
Transportation (Including Automotive)	-0.472 (0.813)	-1.241** (0.0161)			1.676*** (0.00689)
Construction	-0.681 (0.628)	-0.0189 (0.986)			1.978*** (0.000941)
Energy	-15.27*** (7.93e-07)				0.0962 (0.907)
Goods and Services for Industrial and Business Uses	-0.776 (0.263)	-1.449** (0.0121)	0.552 (0.599)	-0.438 (0.835)	0.902** (0.0282)
Comparison Dummy = Consumer Goods and Services					
F-Test for Joint Technology Effects	249*** (0)	100.6*** (0)	5.055 (0.282)	7.125 (0.309)	53.43*** (0.0000000619)
Observations	217	194	110	75	542

APPENDIX F. FULL INDUSTRY SPECIFICATION WITH TRUNCATED DISTRICT VARIABLES

Top row = Coefficient; * = *p*<.10, ** = *p*<.05, *** = *p*<.01; Bottom row = *p*-value	Patent Owner, Definitive Winner	SJ Invalidity, All	SJ Noninfringement plus Stip Jgmt of Noninfringement	Patent Owner, Trial Winner	Invalidity, All (Any Stage)
Foreign Origin of Patent	0.678*** (0.00256)	-0.555 (0.145)	0.0597 (0.817)	0.655** (0.0487)	-1.177*** (0.000223)
Adjusted Number of Citations Received	0.0702 (0.366)	-0.0545 (0.631)	0.0798 (0.340)	0.0862 (0.589)	0.135 (0.184)
Total Prior Art References	0.00128 (0.173)	0.000344 (0.819)	-0.000875 (0.254)	0.00130 (0.711)	-0.00108 (0.229)
Number of Claims	0.00706 (0.136)	-0.000190 (0.977)	0.00255 (0.677)	0.0127* (0.0558)	-0.00703 (0.153)
Age of Patent at Current Litigation Filing	-0.0118 (0.643)	0.0563* (0.0614)	0.00399 (0.863)	0.0643 (0.128)	-0.0118 (0.683)
Number of Defendants	0.0220 (0.517)	-0.0491 (0.392)	-0.0192 (0.443)	0.00211 (0.981)	-0.121* (0.0593)
Number of Asserted Patents	-0.00212 (0.923)	-0.00578 (0.804)	0.00158 (0.940)	-0.00857 (0.874)	0.0327 (0.268)
ED Tex	1.473*** (3.14e-07)	-0.864* (0.0681)	-0.618* (0.0617)	0.583 (0.229)	-1.514*** (0.000919)
D Del	0.241 (0.440)	-0.564 (0.248)	0.214 (0.509)	-0.710* (0.0787)	0.0326 (0.928)
ND Cal	-0.158 (0.727)	0.516 (0.267)	0.274 (0.541)	0.534 (0.400)	0.454 (0.316)
Computer and Other Electronics	-0.0968 (0.858)	-0.260 (0.593)	-0.347 (0.380)	0.0852 (0.948)	-0.207 (0.677)
Semiconductor	1.157 (0.111)	-0.367 (0.676)	-0.460 (0.482)	1.571 (0.244)	-1.920** (0.0132)
Pharmaceutical	1.755*** (0.000149)	-0.728 (0.315)	-0.0242 (0.955)	0.316 (0.793)	-1.028** (0.0366)
Medical Devices, Methods, and Other Medical	0.934* (0.0685)	-0.528 (0.303)	-0.0495 (0.907)	-0.789 (0.527)	-0.0403 (0.938)
Biotechnology (Industry)	-0.229 (0.760)	0.501 (0.463)	-0.378 (0.484)		0.532 (0.600)
Communication	-0.352 (0.499)	0.372 (0.407)	-0.339 (0.338)	-0.716 (0.566)	-0.152 (0.762)
Transportation (Including Automotive)	1.439** (0.0117)	0.0181 (0.975)	-0.321 (0.570)	1.778 (0.177)	-0.117 (0.844)
Construction	0.433 (0.578)	-2.011*** (0.00536)	0.0595 (0.924)	-0.680 (0.638)	0.852 (0.288)
Energy	1.289** (0.0235)		0.238 (0.729)	0.788 (0.536)	-2.060*** (0.000785)
Goods and Services for Industrial and Business Uses	0.369 (0.421)	0.0137 (0.973)	-0.124 (0.705)	0.352 (0.774)	-0.149 (0.745)
Comparison Dummy = Consumer Goods and Services					
F-Test for Joint Technology Effects	41.03*** (1.12e-05)	14.89 (0.0941)	2.794 (0.986)	18.48** (0.0300)	28.14*** (0.00171)
Observations	632	410	506	286	440

Top row = Coefficient; * = *p*<0.10, ** = *p*<0.05, *** = *p*<0.01; Bottom row = *p*-value	Invalidity, § 102 Prior Art, All (Any Stage)	Invalidity, § 103 Obviousness (Any Stage)	Invalidity, § 112 Indefiniteness (Any Stage)	Invalidity, § 112 Inadequate Disclosure (Any Stage)	Direct Infringement, Literal plus DOE (Any Stage)
Foreign Origin of Patent	-0.711 (0.372)	-1.088* (0.0687)	-0.0904 (0.895)	-0.396 (0.701)	0.645*** (0.00626)
Adjusted Number of Citations Received	0.241 (0.201)	-0.0302 (0.899)	-0.193 (0.604)	0.471 (0.160)	0.128 (0.157)
Total Prior Art References	0.000711 (0.729)	-0.00215 (0.438)	-0.00449 (0.489)	-0.00854 (0.582)	0.00322** (0.0106)
Number of Claims	-0.0137 (0.197)	0.00641 (0.537)	-0.00412 (0.791)	0.00812 (0.764)	0.00567 (0.257)
Age of Patent at Current Litigation Filing	0.00103 (0.986)	-0.0296 (0.535)	0.0425 (0.508)	0.0249 (0.892)	-0.0347 (0.199)
Number of Defendants	-0.202 (0.285)	-0.0905 (0.543)	-0.135 (0.242)	-0.213 (0.793)	-0.00179 (0.956)
Number of Asserted Patents	0.0295 (0.691)	0.0864 (0.288)	0.0139 (0.834)	0.185 (0.719)	-0.00672 (0.799)
ED Tex	-1.775* (0.0634)	-0.833 (0.322)	-0.727 (0.431)		0.694** (0.0129)
D Del	-0.329 (0.570)	-0.0432 (0.934)	0.100 (0.949)	0.739 (0.178)	-0.0495 (0.868)
ND Cal	0.468 (0.522)	-0.260 (0.753)	0.666 (0.503)	-0.606 (0.965)	-1.446** (0.0130)
Computer and Other Electronics	-0.377 (0.700)	-1.354 (0.133)	1.754 (0.774)	-2.394 (0.839)	0.447 (0.328)
Semiconductor	-2.260** (0.0208)		2.382 (0.714)	-1.080* (0.0729)	0.799 (0.272)
Pharmaceutical	-1.257 (0.161)	-1.623** (0.0265)		-0.779 (0.638)	2.154*** (9.99e-07)
Medical Devices, Methods, and Other Medical	-1.662 (0.188)	-0.0880 (0.919)	0.951 (0.875)	-2.114 (0.149)	0.710 (0.135)
Biotechnology (Industry)				4.269 (0.700)	1.270* (0.0579)
Communication	-0.268 (0.743)	-0.822 (0.310)	0.873 (0.891)	-0.0834 (0.995)	-0.600 (0.255)
Transportation (Including Automotive)	-0.264 (0.788)	-0.941 (0.222)		1.265 (0.569)	1.737*** (0.00218)
Construction	-0.0972 (0.924)	0.759 (0.420)			2.142*** (0.000634)
Energy	-1.479 (0.114)				1.040 (0.133)
Goods and Services for Industrial and Business Uses	-0.624 (0.380)	-1.408** (0.0417)	1.137 (0.856)	-0.894 (0.406)	0.886** (0.0277)
Comparison Dummy = Consumer Goods and Services					
F-Test for Joint Technology Effects	11.83 (0.223)	11.94 (0.103)	5.341 (0.376)	0.443 (0.931)	52.63*** (0.0000000872)
Observations	227	219	132	107	542