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Are Patent Disclosure and Definiteness Technology Specific?

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John R. Allison* & Lisa Larrimore Ouellette†

Abstract

Although the Patent Act is designed to be uniform across technologies, the conventional wisdom among close watchers of the patent system is that courts have reached very different outcomes when applying the disclosure (enablement and written description) and claim definiteness requirements to different technologies and industries. This conventional wisdom has heretofore not been tested empirically. In an effort to do so, we have created a hand-coded dataset of all 1,144 cases from 1982 to 2012 in which U.S. district courts or the Court of Appeals for the Federal Circuit rendered a decision involving the enablement, written description, or claim definiteness requirements of § 112 of the Patent Act. We coded validity outcomes under these three doctrines on a novel 5-level scale so as to capture significant subtlety in the strength of each decision, and we also coded patents using both technology and industry classifications.

We present both descriptive statistics and regressions that control for other factors. Our results show some statistically significant disparities in § 112 outcomes for different technologies and industries, although fewer than the conventional wisdom might suggest. Just as importantly, our analysis reveals the effects of several other independent variables on § 112 outcomes, regardless of technology or industry, including whether a district court or the Federal Circuit made the last decision in a case, whether a patent claim was drafted in means-plus-function format, and whether a case was decided before or after *Markman v. Westview Instruments* (holding that interpretation of patent claims is solely within the province of the court and not the jury).

Patent disclosure and definiteness have been the focus of much recent debate about the patent system. The § 112 requirements are meant to ensure that inventors hold up their end of the patent bargain by teaching what the invention actually is and how to make and use it, but many observers question how effective these doctrines are in practice. Commentators have argued that the written description doctrine be eliminated and that the enablement and claim definiteness requirement be significantly revised, and the Supreme Court set forth a new test for indefiniteness in 2014, the contours of which remain uncertain. Our results on how disclosure and definiteness have been applied in practice will be helpful in evaluating current proposals for reforming the § 112 requirements.

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Introduction

Patent law is unitary. That is, the patent statute follows a paradigm of one size fits all, rather than having separate regimes for different technologies or industries.[1] But despite patent law's unitary model, commentators have frequently opined that disclosure and definiteness—the requirements that a patent clearly explain what the invention is and how to reproduce it—are applied dissimilarly by courts across different technologies and industries.[2] For example, the conventional wisdom is that § 112 of the Patent Act, which codifies the disclosure and definiteness requirements,[3] has been applied more vigorously to patents in biotechnology and chemistry, but has rarely been used to invalidate software patents. In this article, we strive to ascertain empirically the extent to which this conventional wisdom is true by examining the decisions courts have actually made in § 112 disputes involving different technologies and industries.

We have attempted to collect every case over the thirty-year period from 1982 to 2012 in which a U.S. district court or the Court of Appeals for the Federal Circuit (the court that hears most patent appeals) rendered a decision involving any of three § 112 issues: enablement, written description, or claim definiteness.[4] After extensive data cleaning, we ended up with 1,144 decisions on at least one of these issues. We hand-coded the outcomes of these cases using a 5-level ordinal scale, allowing us to capture subtleties in the strength of each decision. We also placed each patent in one of six technology categories (plus a secondary technology area when warranted) and in one of eleven industry categories.[5] We also coded numerous control variables that might separately influence § 112 outcomes.

Our results include the following:

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[1] *See* Clarisa Long, *Our Uniform Patent System*, FED. LAW., Feb. 2008, at 44.

[2] *See, e.g.*, Dan L. Burk & Mark A. Lemley, *Is Patent Law Technology-Specific?*, 17 BERKELEY TECH. L.J. 1155, 1156 (2002); *see also infra* Part I.

[3] *See* 35 U.S.C. § 112 (2012) (requiring that a patent "enable any person skilled in the art to which it pertains . . . to make and use the same," "contain a written description of the invention," and "conclude with one or more claims particularly pointing out and distinctly claiming . . . the invention").

[4] We explain these three doctrines in more detail in Part I. In short, definiteness requires that other skilled researchers understand what the claimed invention is, while enablement and written description require that they understand how to make and use the invention and that the inventor actually envisioned the claimed invention.

[5] The technologies, described in detail below, are (1) mechanical, (2) electronics, (3) chemistry, (4) biotechnology, (5) software (with sub-categories of business method software patents and non-business method software patents), and (6) optics. The industries are (1) computer and other electronics, (2) semiconductor, (3) pharmaceutical (with sub-categories based on whether the litigation commenced with a generic company filing an Abbreviated New Drug Application (ANDA)), (4) medical devices, methods, and other medical, (5) biotechnology, (6) communications, (7) transportation (including automotive), (8) construction, (9) energy, (10) goods and services for consumer uses, and (11) goods and services for industrial and business uses. These are essentially the same technology and industry categories developed by one of the current authors for previous studies. *See* John R. Allison, Mark A. Lemley & David L. Schwartz, *Our Divided Patent System*, 82 U. CHI. L. REV. (forthcoming 2015), *available at* http://ssrn.com/abstract=2510004 [hereinafter Allison et al., *Divided Patent System*]; John R. Allison, Mark A. Lemley & David L. Schwartz, *Understanding the Realities of Modern Patent Litigation*, 92 TEX. L. REV. 1769 (2014) [hereinafter Allison et al., *Realities of Modern Patent Litigation*].

(1) Descriptive results reveal differences in judicial treatment of some § 112 issues among technologies and industries. Among technologies, patents in the traditional fields of electronics, mechanics, and chemistry had validity outcomes above the all-technology mean, while biotechnology, optics, and software were less likely to survive § 112 challenges. Perhaps surprisingly, software-implemented business method patents were much more likely to stand up to such attacks than were software patents not covering business method inventions.

Among industry groups, our descriptive results also showed what appeared to be meaningful distinctions: patents in the consumer goods and services, ANDA-related pharmaceutical,[6] construction, semiconductor, energy, and biotechnology industry groupings performed above the all-industry mean for the three § 112 issues combined, while those in the transportation (including automotive), industrial/business goods and services, medical devices and methods, communications, pharmaceutical (all), computer and other electronics, and non-ANDA pharmaceutical industry categories fell below the industry mean on the three issues combined. There was little separation among the first five industries scoring below the industry mean, while there was a large performance dropoff to the bottom two (computers/electronics and pharmaceuticals not involved in ANDA litigation).

(2) In regression models, including those controlling for other possible influences on § 112 outcomes, many of the distinctions among technology groups were not statistically significant. Several statistically significant differences did remain, however: electronics patents performed better than those in other technology fields on written description and were only bested by mechanical patents on enablement. At the other end of the technology spectrum, software patents on inventions other than business methods did very poorly on enablement.

There were also only a few statistically significant differences across industry categories. Patents in the computer and electronics industry did very poorly on enablement, regardless of influences by all of the other factors in our model. Those patents in the pharmaceutical industry that were tested in litigation *not* triggered by a generic drug maker's filing of an ANDA also fared very poorly on written description and definiteness grounds. The latter finding likely was caused by the fact that these types of pharmaceutical patents are not the ones that cover FDA-approved drug compositions, but instead relate mostly to various methods. Patents in the semiconductor industry and in consumer goods and services were significantly more likely than those in other industry categories to survive invalidity challenges based on the written description requirement.

(3) Three other independent variables had significant, sometimes highly significant, effects on § 112 outcomes, regardless of technology or industry:

> (a) District courts were much more likely than the Federal Circuit to uphold patents accused of failing the enablement and definiteness requirements, regardless of either technology or industry.
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> (b) Decisions rendered after the Federal Circuit's decision in *Markman v. Westview Instruments*[7] (affirmed by the Supreme Court) were very significantly more likely

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[6] As explained below, litigation that commences with a generic manufacturer filing an ANDA, or an Abbreviated New Drug Application, may be different from non-ANDA-related pharmaceutical litigation, and the litigated patents themselves may be different on average. We thus report results both with all Pharmaceutical litigation combined, and with it separated into ANDA and non-ANDA cases.

[7] Markman v. Westview Instruments, Inc., 52 F.3d 967 (Fed. Cir. 1995) (in banc), *aff'd*, 517 U.S. 370 (1996).

than those made earlier to be in favor of a patent's definiteness in our technology regressions and significantly more likely in the industry regressions.

(c) With a high degree of significance regardless of either technology or industry, and regardless of whether a district court or the Federal Circuit rendered the final decision in the case, patent claims drafted in means-plus-function format were more likely than those drafted in other formats to be held indefinite.

(4) Interestingly, a number of our control variables had little to no statistically significant effect on outcomes. Whether a lawsuit was initiated by a potential infringer as a declaratory judgment action rather than by a patent owner as an infringement action had only a weak effect. The foreign origin of an invention or a foreign priority filing by the patent applicant were not significantly associated with any different likelihood of a given outcome. Whether a patent was reissued showed no association with outcome differences, and we found no effects on the likelihood of any outcome associated with the federal district in which the case was decided.

Our Article proceeds in four Parts. In Part I, we review the conventional wisdom about how courts have applied § 112 across different technologies. Part II describes our data collection strategy and coding methodology. Part III presents our empirical results. Finally, Part IV discusses the implications of our findings, as well as caveats in their interpretation.

I. Is § 112 Technology Specific?

The Supreme Court often describes patents as bargains between inventors and society.[8] In return for the exclusive rights provided by a patent,[9] the inventor must teach others how to create the invention. In particular, § 112 of the Patent Act requires that the inventor's written description and drawings in combination (the patent's "specification") must be sufficiently complete and thorough so as to enable a "person having ordinary skill in the art" (a PHOSITA, in patent law argot) to make and put into practice the invention without having to engage in an undue amount of experimentation, and must demonstrate that at the time of application the inventor clearly envisioned the invention.[10] The former, commonly called the "enablement" requirement, and the

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[8] *See* Festo Corp. v. Shoketsu Kinzoku Kogyo Kabushiki Co., 535 U.S. 722, 736 (2002) ("[E]xclusive patent rights are given in exchange for disclosing the invention to the public."); J.E.M. Ag Supply, Inc. v. Pioneer Hi-Bred Int'l, Inc., 534 U.S. 124, 142 (2001) ("The disclosure required by the Patent Act is 'the quid pro quo of the right to exclude.'" (quoting Kewanee Oil Co. v. Bicron Corp., 416 U.S. 470, 484 (1974))); Pfaff v. Wells Elecs., Inc., 525 U.S. 55, 63 (1998) ("[T]he patent system represents a carefully crafted bargain that encourages both the creation and the public disclosure of new and useful advances in technology, in return for an exclusive monopoly for a limited period of time."); Bonito Boats, Inc. v. Thunder Craft Boats, Inc., 489 U.S. 141, 151 (1989) ("In consideration of [the invention's] disclosure and the consequent benefit to the community, the patent is granted."); *Kewanee Oil*, 416 U.S. at 481 ("[S]uch additions [from patent disclosures] to the general store of knowledge are of such importance to the public weal that the Federal Government is willing to pay the high price of 17 years of exclusive use for its disclosure . . . .").

[9] "Exclusive right" is stated in the positive for reading ease, but the rights of a patent owner, like the rights of owners of other types of property, are negative in nature. A patent confers the right to exclude others from making, using, selling, or offering to sell an identical invention within the United States or from importing such an invention into the United States. *See* 35 U.S.C. § 271(a) (2012).

[10] 35 U.S.C. § 112(a) (requiring that a patent "enable any person skilled in the art to which it pertains . . . to make and use the same" and "contain a written description of the invention"). Section 112 was renumbered and slightly edited by the

latter, the "written description" requirement, are closely related.[11] In addition, the patent bargain requires the inventor to clearly notify the public[12] of the exact contours of the property interest sought by writing "claims" that specify the invention with particularity and distinctness.[13]

These three requirements—enablement, written description, and definiteness—help ensure that the patent teaches other skilled researchers what the invention is and how to reproduce it.[14] (Section 112 also requires that the patent "set forth the best mode . . . of carrying out the invention,"[15] but granted patents may no longer be invalidated for failure to disclose the best mode,[16] so we do not analyze this requirement here.)

The enablement and written description requirements are closely related in that both represent a lack of synchronicity between the disclosures in the patent specification and the claims in that same document. For example, the greater the breadth, or language generality, of a particular claim, the higher the probability that the specification will not have adequately "enabled" the claim and will not have revealed exactly the invention delineated in this claim.[17] The reverse is likewise true. The enablement and written description requirements also are distinct in that it is not only possible but quite common to violate one but not the other. The specification can reveal that the

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Leahy-Smith America Invents Act, Pub. L. No. 112-29, § 4(c), 125 Stat. 284, 296 (2011). These technical changes are not relevant to our discussion here.

[11] The Federal Circuit recently affirmed the existence of written description as a separate patentability requirement from enablement, *Ariad Pharmaceuticals, Inc. v. Eli Lilly & Co.*, 598 F.3d 1336 (Fed. Cir. 2010) (en banc), although numerous commentators have criticized this distinction, *see, e.g.*, Allen K. Yu, *The En Banc Federal Circuit's Written Description Requirement: Time for the Supreme Court to Reverse Again?*, 33 CARDOZO L. REV. 895 (2012). We do not take a position in this debate; rather, we focus only on describing how the § 112 requirements have been applied in practice.

[12] The "public" is that of relevant PHOSITAs.

[13] "The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention." 35 U.S.C. § 112(b).

[14] For a review of the disclosure requirements, see generally Lisa Larrimore Ouellette, *Do Patents Disclose Useful Information?*, 25 HARV. J.L. & TECH. 531, 536–39 (2012).

[15] 35 U.S.C. § 112(a).

[16] America Invents Act § 15, 125 Stat. at 328 (codified at 35 U.S.C. § 282).

[17] It is often said that a failure to fulfill the written description requirement occurs when that description, at the time of filing, does not show that the inventor was "in possession of the invention" specified in the claim in question. Although a violation of this disclosure requirement may occur with respect to a claim as it exists at the time the original patent application is filed, it is perhaps more common for such a failing to become manifest when the language of a claim is altered or a new claim is added after initial filing, either during prosecution of the application in the U.S. Patent & Trademark Office (PTO) or later in a "continuing" application. The many legal ramifications of claim drafting strategies and the use of continuing applications are far beyond the scope of this paper. Speaking very generally, however, the claims can be changed or new claims added without direct penalty either during prosecution or in a continuing application that is filed while either the original application or another "ancestor" application in an application chain is still pending, but that the written description and drawings (specification) cannot. This fact leads to the very real possibility of a disconnect existing between the specification and a particular claim. Moreover, a claim in a later-filed continuing application cannot enjoy the benefit of the filing date of the earlier application, including "cutting off" prior art that might be used to invalidate the claim, unless the earlier application fulfills both disclosure requirements with respect to that later claim. Statutory authority for continuing applications and requirements for retaining the earlier filing date are found in 35 U.S.C. § 120 (2012).

applying inventor clearly had in mind the exact invention in a claim that is in issue, thus fulfilling the "written description" requirement, but not supply enough detail about things like manufacturing processes, materials, or software algorithms to enable a skilled person in the technology field to make and use this claimed invention, either at all or without having to experiment an unreasonable amount.[18] Conversely, the specification may contain such far-ranging and thorough explanation of the relevant technology and the details of making and using various related inventions so as to enable a PHOSITA to make and use a class of inventions that includes the one in the claim of concern, but that same specification may reveal no signs that the inventor had this particular invention in mind when filing the patent application.[19]

The third § 112 issue of interest, claim definiteness, demands that the patent claims clearly demarcate the boundaries of the property interests for which the inventor seeks protection. This requirement has recently been in flux, with a potentially major change having occurred in the Supreme Court's 2014 *Nautilus v. Biosig* decision.[20] For some time, the Federal Circuit had minimally required that a claim need only be susceptible to construction and "not insolubly ambiguous" to satisfy the definiteness requirement.[21] Toward the end of its 2014 term, however, the Supreme Court arguably abrogated this lax standard by instituting one calling for the language of a patent claim to delineate the invention such that a PHOSITA can understand its scope with "reasonable certainty."[22] Although the Court's language seems to call for imposition of a stricter definiteness requirement, the extent to which it actually does largely remains to be seen.[23]

The Patent Act contains no indication that these § 112 requirements should be applied differently to different technologies, and the international TRIPS agreement prohibits

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[18] For example, certain biotechnology patents are not enabled without placing necessary microorganisms in a public materials depository, even if the patent document clearly satisfies the written description requirement. *See generally* Lisa Larrimore Ouellette, *Access to Bio-Knowledge: From Gene Patents to Biomedical Materials*, 2010 STAN. TECH. L. REV. N1, ¶¶ 102-05 (explaining the use of these depositories to satisfy enablement).

[19] Explaining in the abstract how a patent specification can enable a given claim but fail to fulfill the written description requirement for that same claim is reminiscent of explaining in the abstract how to pull the engine and transmission from a Mack truck. Many cases provide concrete examples. *See, e.g.*, *In re* Curtis, 354 F.3d 1347 (Fed. Cir. 2004); Gentry Gallery, Inc. v. Berkline Corp., 134 F.3d 1473 (Fed. Cir. 1998); Fujikawa v. Wattanasin, 93 F.3d 1559 (Fed. Cir. 1996).

[20] Nautilus, Inc. v. Biosig Instruments, 134 S. Ct. 2120 (2014).

[21] *See, e.g.*, Datamize, LLC v. Plumtree Software, Inc., 417 F.3d 1342, 1347 (Fed. Cir. 2005). For an argument that the PTO has allowed many patents to issue with improperly uncertain claim language by following Federal Circuit precedent that should apply only to issued patents with their strong presumption of validity and not to those in a patent application before it has been allowed, see Jonathan S. Masur & Lisa Larrimore Ouellette, *Deference Mistakes*, 82 U. CHI. L. REV. (forthcoming 2015), *available at* http://ssrn.com/abstract=2411543.

[22] *Nautilus*, 134 S. Ct. at 2124 ("In place of the 'insolubly ambiguous' standard, we hold that a patent is invalid for indefiniteness if its claims, read in light of the specification delineating the patent, and the prosecution history, fail to inform, with reasonable certainty, those skilled in the art about the scope of the invention.").

[23] Although a number of lower court decisions have ruled on challenges to the definiteness of patent claims since the Supreme Court's *Nautilus* decision, it is beyond the scope of this empirical paper to engage in a doctrinal analysis of the decision's effect on lower court rulings.

"discrimination as to . . . the field of technology" in national patent laws.[24] Although some have doubted the wisdom of continuing the unitary model because of the different needs of innovators in different fields,[25] a move toward separate patenting rules for particular technologies or industries would produce unintended negative consequences. For example, such an approach would inevitably lead to strategic drafting and classification of patents to fit more favorable technology classifications, leading to increased transaction costs associated with tortuous drafting to make an invention appear to be something different from what it really is.[26]

But numerous observers of the patent system have argued that "while patent law is technology-neutral in theory, it is technology-specific in application,"[27] including in the application of § 112. The following two Sections describe the conventional wisdom that § 112 is applied more vigorously to patents in biotechnology and chemistry, whereas it is rarely used to invalidate claims in software. Then, in Section I.C, we review the few prior empirical studies of how § 112 has been applied in practice.

A. Heightened Standards in Biotechnology and Chemistry?

Many commentators have suggested that courts apply a higher enablement and written description standard in biotechnology and chemistry. For example, Arti Rai wrote that the Federal Circuit "has used the written description requirement in a manner that somewhat raises the patentability bar" for biotechnology inventions.[28] Sean Seymore has similarly stated that "[i]n contrast to the applied sciences [like electrical and mechanical engineering], the judiciary has

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[24] Agreement on Trade-Related Aspects of Intellectual Property Rights art. 27, Apr. 15, 1994, Marrakesh Agreement Establishing the World Trade Organization, Annex 1C, 1869 U.N.T.S. 299.

[25] *See, e.g.*, Michael Abramowicz, *Orphan Business Models: Toward a New Form of Intellectual Property*, 124 HARV. L. REV. 1362, 1406-07 (2011); Jonathan S. Masur, *Regulating Patents*, 2010 SUP. CT. REV. 275, 321-24; Benjamin N. Roin, *The Case for Tailoring Patent Awards Based on the Time-to-Market of Inventions*, 61 UCLA L. REV. 672 (2014); Neel U. Sukhatme, *Regulatory Monopoly and Differential Pricing in the Market for Patents*, 71 WASH & LEE L. REV. (forthcoming 2015), *available at* http://ssrn.com/abstract=2431473. For a critique of the dominant push toward uniformity in patent law on policy learning grounds, see Lisa Larrimore Ouellette, *Patent Experimentalism*, 101 VA. L. REV. (forthcoming 2015), *available at* http://ssrn.com/abstract=2294774.

[26] *See, e.g.*, John R. Allison & Starling D. Hunter, *On the Feasibility of Reforming Patent Quality One Technology at a Time: The Case of Business Methods*. 21 BERKELEY TECH. L.J. 729 (2006). This paper provides evidence that patent attorneys strategically drafted applications to avoid the PTO's "business method" classification when the agency increased scrutiny of such claims through its "second pair of eyes" initiative in March 2000. There is, of course, nothing wrong with a patent attorney doing this, and is probably within the scope of her obligation to the client to save time and money. Patent attorneys have done similar things over the years to disguise software patents as judicial approaches toward such patents have waxed and waned. *Id.* Patent attorneys likely would be able to engage in such behavior often enough to meaningfully undercut reforms based on explicit distinctions between different technologies or industries.

[27] Burk & Lemley, *supra* note 2, at 1156.

[28] Arti K. Rai, *Intellectual Property Rights in Biotechnology: Addressing New Technology*, 34 WAKE FOREST L. REV. 827, 834 (1999).

required more detailed disclosure in chemistry and the experimental sciences."[29] Dan Burk and Mark Lemley have repeatedly written about "stringent enablement and written description requirements on biotechnology patents that do not show up in other disciplines."[30]

The high enablement and written description requirements in biotechnology and chemistry have become popular topics for student notes, with assertions such as that "the biotechnology and pharmaceutical industries, in particular, have become subject to more stringent written description requirements,"[31] and that "heightened enablement and written description requirements for biotechnology" have "effectively eliminated patent protection for biotechnology inventions pertaining to proteins."[32] Similar examples are easy to find.[33] Indeed, a search of Westlaw's law journal database for "heightened," "strict," or "stringent" enablement or written description in the context of biotechnology had over 100 results.[34]

The typical explanation for higher disclosure requirements in chemistry and biotechnology is that these are "unpredictable" arts in which more details are required than in "predictable" fields such as mechanical and electrical inventions.[35] But many commentators suggest that the written description standard in biotechnology is particularly rigid, with blame placed primarily on the

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[29] Sean B. Seymore, *Heightened Enablement in the Unpredictable Arts*, 56 UCLA L. REV. 127, 137 (2008) [hereinafter Seymore, *Heightened Enablement*]; *see also* Sean B. Seymore, *The Enablement Pendulum Swings Back*, 6 NW. J. TECH. & INTELL. PROP. 278, ¶¶ 6-7 (2008) [hereinafter Seymore, *Enablement Pendulum*] (noting that chemistry patents have required "a specific and detailed teaching" and that the Federal Circuit has made clear that mechanical patents are "not in the same category as the chemical arts").

[30] Burk & Lemley, *supra* note 2, at 1156; *see also* Dan L. Burk & Mark A. Lemley, *Biotechnology's Uncertainty Principle*, 54 CASE W. RES. L. REV. 691, 691 (2004) [hereinafter, Burk & Lemley, *Uncertainty Principle*] ("[T]he [Federal Circuit] claims that the uncertain nature of [biotechnology] requires imposition of stringent patent enablement and written description requirements that are not applied to patents in other disciplines."); Dan L. Burk & Mark A. Lemley, *Policy Levers in Patent Law*, 89 VA. L. REV. 1575, 1654 (2003) (expressing the same sentiment) [hereinafter, Burk & Lemley, *Policy Levers*].

[31] Corrin Nicole Drakulich, Note, University of Rochester v. G.D. Searle & Co.*: In Search of a Written Description Standard*, 21 BERKELEY TECH. L.J. 11, 11–12 (2006).

[32] Sheila R. Arriola, *Biotechnology Patents After* Festo*: Rethinking the Heightened Enablement and Written Description Requirements*, 11 FED. CIRCUIT B.J. 919, 919 (2002).

[33] *See, e.g.*, Alison E. Cantor, Note, *Using the Written Description and Enablement Requirements to Limit Biotechnology Patents*, 14 HARV. J.L. & TECH. 267, 268 (2000) (arguing that courts have "appl[ied] aspects of the written description and enablement requirements more stringently in this field in order to limit the scope of biotechnology patents."); Matthew A. Chivvis, Comment, *Improving Innovation by Reducing the Risk of Investing in Biotechnology: Fixing the Enablement Standard*, 11 INTELL. PROP. L. BULL. 205, 206 (2007) ("In its infancy, the biotechnology field faced an incredibly strict enablement standard. Yet, as biotechnology has matured and its practitioners' skills have increased, the courts have failed to relax the standard accordingly." (footnote omitted)); Natalie A. Lissy, Note, *Patentability of Chemical and Biotechnology Inventions: A Discrepancy in Standards*, 81 WASH. U. L.Q. 1069, 1085 (2003) ("Because of the unpredictability of the properties of seemingly-related compounds, this [written description] standard is heightened in chemical cases.").

[34] Search was performed in Westlaw's JLR database for [(enablement "written description") /s (biotech!) /s (heightened stringent strict)] on January 4, 2015.

[35] *See, e.g.*, Seymore, *Heightened Enablement*, *supra* note 29, at 136-39.

Federal Circuit's 1997 decision in *Regents of the University of California v. Eli Lilly & Co.*[36] In *Eli Lilly*, the Federal Circuit held that the written description requirement was not satisfied for a DNA claim without disclosure of the DNA sequence.[37] Treatise author Janice Mueller calls this "a significant departure from prior written description cases" that "sets a significantly higher standard for the protection of biotechnological inventions."[38] This case sparked an intense debate within the Federal Circuit. When dissenting from denial of rehearing en banc in another written description case, Chief Judge Rader included an appendix of academic commentary, primarily criticizing *Eli Lilly* for its heightened standard.[39] Judge Lourie contested this point in his explanation of the en banc denial, stating that "it is not correct, as has been asserted, that our decisions . . . have created a 'heightened' written description requirement for biotechnology inventions" because the court has applied the same standard "to cases that are not in the fields of chemistry or biotechnology."[40]

But perhaps the disclosure requirements for biotechnology or chemistry inventions are not currently higher than for other inventions because the high standard was exported from these fields to other arts. For example, Mark Janis has suggested that the written description requirement has been "applied with unaccustomed vigor" even in the "'predictable' arts."[41] And both Bernard Chao and Sean Seymore have argued that three Federal Circuit cases from 2007 and 2008 have expanded the strong enablement defense from "the unpredictable arts (e.g. chemical or biotechnology)" to "technology that would normally be considered to fall within the predictable arts."[42]

Finally, note that stringent *disclosure* requirements in biotechnology or chemistry do not

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[36] 119 F.3d 1559 (Fed. Cir. 1997).

[37] *Id.* at 1566–67.

[38] Janice M. Mueller, *The Evolving Application of the Written Description Requirement to Biotechnological Inventions*, 13 BERKELEY TECH. L.J. 615, 633 (1998); *see also* David Kelly, *The Federal Circuit Transforms the Written Description Requirement into a Biotech-Specific Hurdle to Obtaining Patent Protection for Biotechnology Patents*, 13 ALB. L.J. SCI. & TECH. 249 (2002) (expressing a similar sentiment).

[39] Univ. of Rochester v. G.D. Searle & Co., 375 F.3d 1303, 1314–24 (Fed. Cir. 2004) (Rader, C.J., dissenting from the denial of rehearing en banc).

[40] *Id.* at 1306 (Lourie, J., concurring in the denial of rehearing en banc) (citing *In re* Curtis 354 F.3d 1347 (Fed. Cir. 2004) (dental floss); Tronzo v. Biomet, Inc., 156 F.3d 1154 (Fed. Cir. 1998) (artificial hip sockets); Gentry Gallery, Inc. v. Berkline Corp., 134 F.3d 1473 (Fed. Cir. 1998) (sectional sofas); Lockwood v. Am. Airlines, Inc., 107 F.3d 1565 (Fed. Cir. 1997) (automated sales terminals); Vas-Cath Inc. v. Mahurkar, 935 F.2d 1555 (Fed. Cir. 1991) (double lumen catheters)).

[41] Mark D. Janis, *On Courts Herding Cats: Contending with the "Written Description" Requirement (and Other Unruly Patent Disclosure Doctrines)*, 2 WASH. U. J.L. & POL'Y 55, 60 (2000).

[42] Bernard Chao, *Rethinking Enablement in the Predictable Arts: Fully Scoping the New Rule*, 2009 STAN. TECH. L. REV. 3, ¶¶ 6–8 (2009) (citing Sitrick v. Dreamworks, LLC, 516 F.3d 993 (Fed. Cir. 2008) (integration of audio or visual signal into video games or movies); Auto. Techs. Int'l, Inc. v. BMW of N. Am., Inc., 501 F.3d 1274 (Fed. Cir. 2007) (vehicle side-impact crash sensors); Liebel-Flarsheim Co. v. Medrad, Inc., 481 F.3d 1371 (Fed. Cir. 2007) (medical fluid injection system)); Seymore, *Enablement Pendulum*, *supra* note 29, at ¶¶ 16-24 (discussing the same three cases); *see also* Jason Romrell, Note, *Biting Off More Than You Can Chew: The New Law of Enablement*, 23 BERKELEY TECH. L.J. 139, 139 (2008) (arguing that *Liebel-Flarsheim* and *Automotive Technologies* imported the "stringent standard" from biotechnology and chemistry to the predictable arts).

necessarily mean that the *definiteness* requirement of § 112 is also rigorously applied. Indeed, Kevin Collins argues that a high written description hurdle for biotechnology patents "may compensate for the fact that the Federal Circuit has failed to apply in the biotechnology sector the means-plus-function rules that limit the scope of functionally defined claims in other sectors."[43] In other words, he suggests that the definiteness standard is *lower* in biotechnology than in other disciplines.

B. Lower Standards in Software and Business Methods?

In contrast to biotechnology and chemistry, for software innovations the enablement and written description standards are perceived to be quite relaxed. For example, Burk and Lemley have argued that "[t]he Federal Circuit has essentially excused software inventions from compliance with . . . enablement" and that the high written description standard in biotechnology "would be inconceivable in other industries, such as software."[44] Kathy Strandburg notes the "low standards for enablement and description" in software and business methods.[45] Other examples abound,[46] and we have not found any commentators who dispute this consensus.

Commentators have also argued that the definiteness requirement is insufficiently enforced in the software context. For example, Mark Lemley has argued that courts should treat many more software patent claims as "means plus function" claims under 35 U.S.C. § 112(f), which are invalid for indefiniteness if they "do not detail actual algorithms implementing those functional steps."[47] But this does not mean that one would expect to find fewer invalidations for indefiniteness in software than other fields—before *Nautilus v. Biosig*,[48] the indefiniteness standard was generally viewed as "toothless" for all technologies.[49] And even before *Nautilus*, courts were using indefiniteness to curb a number of overbroad software patents,[50] even if not as often as some

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[43] Kevin Emerson Collins, *An Initial Comment on* Ariad*: Written Description and the Baseline of Patent Protection for After-Arising Technology*, 2010 PATENTLY O-PAT. L.J. 60.

[44] Burk & Lemley, *Policy Levers*, *supra* note 30, at 1593, 1653–54; Burk & Lemley, *supra* note 2, at 1156 (expressing the same idea); Burk & Lemley, *Uncertainty Principle*, *supra* note 30, at 706–07 (showing that the written description requirement in software is "antithetical" to that for biotechnology).

[45] Katherine J. Strandburg, *Patent Fair Use 2.0*, 1 UC IRVINE L. REV. 265, 285 (2011).

[46] *See, e.g.*, Ronald J. Mann, *Do Patents Facilitate Financing in the Software Industry?*, 83 Tex. L. Rev. 961, 1026 (2005) (noting that "low threshold for enablement" in software); Greg R. Vetter, *Patent Law's Unpredictability Doctrine and the Software Arts*, 76 MO. L. REV. 763, 766 (2011) (stating that "disclosure burdens are light" for software); Ajeet P. Pai, Note, *The Low Written Description Bar for Software Inventions*, 94 VA. L. REV. 457, 460 (2008).

[47] Mark A. Lemley, *Software Patents and the Return of Functional Claiming*, 2013 WIS. L. REV. 905, 945.

[48] Nautilus, Inc. v. Biosig Instruments, Inc., 134 S. Ct. 2120 (2014).

[49] Ronald Mann, *Argument Preview: Justices To Wade into Morass About "Indefinite" Claims in Patents*, SCOTUSBLOG (Apr. 17, 2014), http://www.scotusblog.com/2014/04/argument-preview-justices-to-wade-into-morass-about-indefinite-claims-in-patents.

[50] *See id.* ("[W]hen software patents are actually written using 'means for doing x' language, the Federal Circuit has been quite strict about requiring evidence of real computer programming in the specification."); *see also* Kevin

commentators would like.

C. Prior Empirical Work

The conventional wisdom about the application of § 112 across technologies tends to be based on analyses of a few cases, which may not represent broader litigation trends. Although no one has comprehensively studied how § 112 outcomes vary by technology in the detail we present here, there is a growing empirical literature on litigation outcomes. Much of this work does not separate § 112 from other invalidity results.[51] Other works—including a study by one of us—have examined the separate § 112 doctrines but do not classify cases by technology or industry.[52] But a few works have begun to describe how § 112 is applied in different technologies. This Section briefly reviews this prior work.

In one study, Chris Holman found all opinions from the federal courts and the Board of Patent Appeals and Interferences (BPAI) from 1997 to 2006 that applied the written description doctrine as set forth in the Federal Circuit's *Eli Lilly* decision.[53] As discussed above, many commentators viewed this decision as heightening the written description requirement for biotechnology.[54] Holman found four Federal Circuit opinions, one district court opinion, and nine BPAI decisions invalidating patent claims under the *Eli Lilly* rule; in comparison, he found six Federal Circuit opinions, ten district court opinions, and twenty-two BPAI decisions rejecting validity challenges.[55] He qualitatively described the technology at issue in each case, but was able to

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Emerson Collins, *Patent Law's Functionality Malfunction and the Problem of Overbroad, Functional Software Patents*, 90 WASH. U.L. REV. 1399, 1451 (2013) ("[T]he Federal Circuit has recently begun to invalidate means-plus-function software claims for indefiniteness if the patent specification fails to disclose an algorithm for achieving the claimed function.").

[51] *See* Colleen V. Chien, *Predicting Patent Litigation*, 90 TEX. L. REV. 283 (2011) (comparing a randomly selected group of 659 litigated patents issued in 1990 with matched unlitigated patents); Paul M. Janicke & LiLan Ren, *Who Wins Patent Infringement Cases?*, 34 AIPLA Q.J. 1 (2006) (examining all 262 dispositive Federal Circuit decisions, including affirmances without opinion, from 2002 to 2004); Jay P. Kesan & 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 (2006) (examining about 6300 patent cases filed in 1995, 1997, and 2000).

[52] All published Federal Circuit patentability rulings over five different years were coded for validity outcomes by Lisa Larrimore Ouellette, *What Are the Sources of Patent Inflation? An Analysis of Federal Circuit Patentability Rulings*, 121 YALE L.J. ONLINE 347 (2011). Of these 324 cases, 15 (5%) involved enablement (4 valid/patentable, 6 mixed rulings, 5 invalid/unpatentable), 32 (10%) involved written description (11 valid, 9 mixed, 12 invalid), and 28 (9%) involved indefiniteness (14 valid, 5 mixed, 9 invalid). *Id.* at 357-59 (with § 112-specific outcomes drawn from the original data).

[53] Christopher M. Holman, *Is* Lilly *Written Description A Paper Tiger?: A Comprehensive Assessment of the Impact of* Eli Lilly *and Its Progeny in the Courts and PTO*, 17 ALB. L.J. SCI. & TECH. 1, 4 (2007) (searching for written description cases citing *Regents of the Univ. of Cal. v. Eli Lilly & Co.*, 119 F.3d 1559 (Fed. Cir. 1997), or any subsequent Federal Circuit cases that applied the Lilly rule). Dennis Crouch also examined written description decisions of the BPAI in a subsequent study, and he showed which technology centers the decisions studied came from, but he did not give outcomes by technology. Dennis Crouch, Essay, *An Empirical Study of the Role of the Written Description Requirement in Patent Examination*, 104 NW. U. L. REV. 1665, 1676–78 (2010).

[54] *See supra* notes 36–40 and accompanying text.

[55] Holman, *supra* note 53, at 26, 37, 42, 58, 70.

conclude only that it remains unclear whether *Eli Lilly*'s written description doctrine is "particularly directed towards biotechnology" or not.[56]

Two student works claim to find differences between technologies but are limited by small sample sizes. In one, Christa Laser divided forty-eight Federal Circuit indefiniteness opinions into four technology areas and reported that the claims at issue were held definite in the one biochemical case, in 10 of 14 chemical cases, in 10 of 16 electrical cases, and in 11 of 17 other cases.[57] While a useful contribution, the small sample sizes do not really support the finding reported in her abstract that "the Federal Circuit more often held chemical claims not indefinite, but electrical claims indefinite."[58] In the second student work, Dunstan Barnes examined 138 Federal Circuit opinions between 1997 and 2011 that reached the merits of a written description or enablement issue.[59] He reported that for the 40 biotechnology patents the invalidation rate was 62.5% and that for the 98 other patents it was 58.2%, and he erroneously claimed that this small difference was statistically significant.[60]

Finally, the most detailed data comes from a forthcoming article in which one of us has examined all substantive patent litigation decisions in cases filed in 2008 and 2009, using the same technology and industry classifications reported here.[61] This study reveals some interesting insights into § 112 litigation, but whether any of the regression results for inadequate disclosure (enablement or written description) and indefiniteness are statistically significant depends on which of several model specifications is employed,[62] and it is thus difficult to draw any firm conclusions. Moreover, this study is limited to cases filed in only two years, rather than the much broader time range examined here.

II. Data and Methodology

A. Data Collection

In this article, we seek to test empirically the conventional wisdom that courts have applied

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[56] *Id.* at 80–81.

[57] Christa J. Laser, *A Definite Claim on Claim Indefiniteness: An Empirical Study of Definiteness Cases of the Past Decade with a Focus on the Federal Circuit and the Insolubly Ambiguous Standard*, 10 CHI.-KENT J. INTELL. PROP. 25, 35 tbl.4 (2010).

[58] *Id.* at 25.

[59] Dunstan H. Barnes, Note, *Technically Speaking, Does It Matter? An Empirical Study Linking the Federal Circuit Judges' Technical Backgrounds to How They Analyze the Section 112 Enablement and Written Description Requirements*, 88 CHI.-KENT L. REV. 971 (2013).

[60] *Id.* at 1006. Barnes erroneously reported that this difference was "statistically significant ($p < 0.05$) under Pearson's chi-squared test." *Id.* This is incorrect; the p-value under the chi-squared test is actually 0.64. In other words, there is a 64% probability that the difference Barnes observed is simply due to chance.

[61] Allison et al., *Divided Patent System*, *supra* note 5.

[62] *Id.* 1t 70-88.

§ 112 requirements disparately across different technologies and industries. To do so, we began by collecting substantially all of the cases decided by district courts and the Court of Appeals for the Federal Circuit between 1982, the year of the Federal Circuit's creation, and July 2012. We used Westlaw to search for cases, employing an intentionally overinclusive search request that sought all cases in which § 112 had been referred to in any way.[63] From the results of this search, we culled out all cases that did not include an actual ruling on an accused infringer's challenge to the validity of a patent asserted in litigation[64]. Federal Circuit cases decided between July 2012 and September 10, 2014 were added to this collection.[65] We attempted to achieve a complete census, or population, of § 112 cases decided during this period rather than taking a sample. We undoubtedly missed a few, but we believe that we have a substantially complete population.

B. Case Outcomes

Because multiple patents are often asserted in a single case, and the same patent can be asserted in multiple cases, our basic unit of analysis may properly be referred to as a patent-case pair, of which we have 1,144 in our data set.[66] Some patent-case pairs in our data set include decisions on more than one of the three § 112 requirements for the same patent, so the total number of separate *decisions* is actually 1,405: there are 433 decisions on enablement, 299 on written description, and 673 on claim definiteness.

We coded the last recorded merits decision in a case on any of the three § 112 issues; thus, for example, a district court's denial of the accused infringer's motion for summary judgment that the patent is invalid for lack of enablement because a fact issue remains is the decision we report if it is the last recorded decision in the case, but if the patent is later found either valid or invalid at trial, we do not report the earlier decision on summary judgment. The same logic applies to other situations, so that when the last decision on record is by the Federal Circuit, we do not record the trial court's last decision on the same issue.

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[63] Had Lex Machina, Inc.'s database of patent cases included those filed closer to the starting date of our desired population, we would have preferred to use it as the source for district court decisions because it includes even those lawsuits that do not have a decision available on Westlaw. *See* Allison et al., *Realities of Modern Patent Litigation*, *supra* note 5, at 1772-73. However, Lex Machina only indexes cases filed since January 1, 2000. Because Westlaw includes large numbers of officially "unpublished" and other non-precedential decisions, we believed that using Lex Machina to find district court cases for the last one-third of our target time period would not have yielded a large enough number of additional lower court patent decisions to make the sizeable time investment worthwhile.

[64] We included denials of summary judgment when these were the last recorded decisions.

[65] Four of these Federal Circuit decisions were decided after the Supreme Court's June 2, 2014 decision on the definiteness requirement in *Nautilus, Inc. v. Biosig Instruments*, 134 S. Ct. 2120 (2014). In these four cases, the court rendered claim definiteness decisions on seven patents. We decided to include these seven case-patent pairs in our data set because the research question we seek to answer empirically is whether district courts and the Federal Circuit have over time applied the three § 112 patentability requirements disparately *across technologies and industries*, irrespective of doctrinal changes in one of these requirements.

[66] We encountered a small number of instances in which courts rendered different decisions on claim definiteness for different claims or within the same patent; when this occurs, there is more than one unit of study for the same patent. In such a case, we created more than one row in our spreadsheet for the same patent. These additional decisions are counted within the total 1,144 observations.

Determining exactly what an "outcome" is for the purpose of empirically studying litigation, particularly patent litigation, is notoriously difficult. As noted, we seek to resolve one of the inherent difficulties by recoding decisions at the level of a patent rather than at the level of a case. We seek to minimize yet another problem—what counts as a "win" on a legal issue when assembling data for statistical analysis—by recording the relative strength of each decision on the following 5-level ordinal scale: (1) invalid as a matter of law; (2) fact issue followed by a ruling of invalidity; (3) fact issue remaining; (4) fact issue followed by a ruling of validity; or (5) valid as a matter of law.[67]

We also created a courser 1 to 3 scale by collapsing "as a matter of law" and "fact issue followed by a validity or invalidity ruling" to produce "total valid" and "total invalid" outcomes on each of the three issues. Thus, our 3-level scale in ascending order of decision strength in the patent owner's favor is (1) valid, (2) fact issue remaining, and (3) invalid.

We coded a decision as one made as a matter of law, whether for validity or validity, if a district court granted summary judgment or judgment as a matter of law (pre- or post-verdict JMOL) on the issue at hand or ruled on an indefiniteness argument as a matter of law in a claim construction order. On appeal, the decision was recorded as one made as a matter of law if the Federal Circuit either affirmed or reversed the decision below as a matter of law. We coded a decision as "fact issue followed by a ruling of validity or invalidity" when a district court allowed an issue to go to trial because a genuine issue of fact was involved and then found the patent valid or invalid on the issue in question in a bench trial, or granted a judgment of validity or invalidity in accordance with a jury's verdict. On appeal, the decision was recorded as such when the Federal Circuit affirmed a district court's decision of "fact issue followed by a ruling of validity or invalidity." A decision was coded as "fact issue remaining" if the last reported decision in a district court case was a denial of a motion for summary judgment or pre-verdict JMOL. On appeal, a decision was so recorded when the last reported decision was the Federal Circuit's reversal and remand of a district court's grant of summary judgment or pre-verdict JMOL.

Because our collection of district court cases ended with decisions as of July 31, 2012, and our coding of outcomes did not begin until September 2014, we were able to use Westlaw's KeyCite "flag" service to update those decisions, thus adding some certainty that the decisions we recorded were the last ones in the case. We of course used the flag service to update all Federal Circuit decisions, as well. Consequently, it is highly likely that when the last reported decision was "fact issue remaining," the parties had reached a settlement.

C. Technology and Industry Classifications

The heart of this paper is our comparison of nuanced outcomes on the issues of enablement, written description, and claim definiteness 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

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[67] Technically, "valid" means "not invalid" because the burden of proving the invalidity of an issued patent is on the challenger, and the court's ruling in such a case is that the challenger has not met its burden of proof. Thus, the patent is ruled not invalid. The validity of the same patent can again be contested by another challenger, although a final ruling of invalidity kills the patent from then on. The situation has been referred to as "non-mutual collateral estoppel." See *In re* Trans Texas Holdings Corp., 498 F.3d 1290, 1297 (Fed. Cir. 2007).

technology is put to use. In one instance, biotechnology, we use the same term to describe both technology and industry; a patent on a gene sequence used in gene therapy is both a biotech technology and is used in the biotech industry. But the two are not identical. Thus, a substantial majority of patents covering biotechnology techniques, i.e., biotech as a technology, were assigned either to the medical industry because the patented technology's covered use was for medical diagnostics and other medical techniques, or to the pharmaceutical industry because the technology produced a covered pharmaceutical drug.

As another example, some patents that cover software technology are employed in traditional software industries like "computers and other electronics," but software as a technology also shows up in a wide array of other industries, including transportation/automotive, consumer goods, industrial goods, energy, medical devices/methods, and others.

While the U.S. Patent and Trademark Office (PTO) has a technology classification scheme, it was not created for the purpose of defining technologies at a conceptual level and possesses other serious shortcomings that have been discussed in connection with prior research published by one of the current authors.[68] We wanted a series of broad categories that would each capture inventions of different types, but that employed the same fundamental technological tools. As a result, we evaluated each 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. With minor revisions, these are the same technology and industry categories developed by one of the current authors for a number of previous studies.[69]

1. Technologies

When determining the technology area to which an invention should be assigned, we placed emphasis on the claims, sometimes aided by the written description 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 usually did not have 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 was done when another technology area clearly formed an additional but integral part of the claims. When only primary technology areas are counted, there are, of course, the same number of observations (1,144) as there are case-patent pairs. When both primary and secondary technology areas are included, the 1,144 patent-case pairs included a total of 1,330 technology areas for an average of 1.16 tech 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:

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[68] *See, e.g.,* John R. Allison, Mark A. Lemley, Kimberly A. Moore & Derek Trunkey, *Valuable Patents*, 92 GEO. L.J. 435 (2004). 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 (IPCs, which the PTO assigns from a concordance based on the PTO's own classifications) may be an unavoidable shortcut.

[69] For the two most recent papers using these technology and industry areas, see Allison et al., *Divided Patent System*, *supra* note 5; and Allison et al., *Realities of Modern Patent Litigation*, *supra* note 5.

(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.

(2) Electronics: An invention in which the claims cover the use of traditional electronic 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 specific 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 semiconductors.

(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.[70]

(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.

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 the claims of which obviously covered only such things as automated generation of customer proposals, advertising, financial techniques, the use of online catalogs, and so on. We do not include computer-controlled manufacturing methods in the business method category because they are not customarily viewed as being within the definition of a business method patent, although a broad definition could contain them.

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

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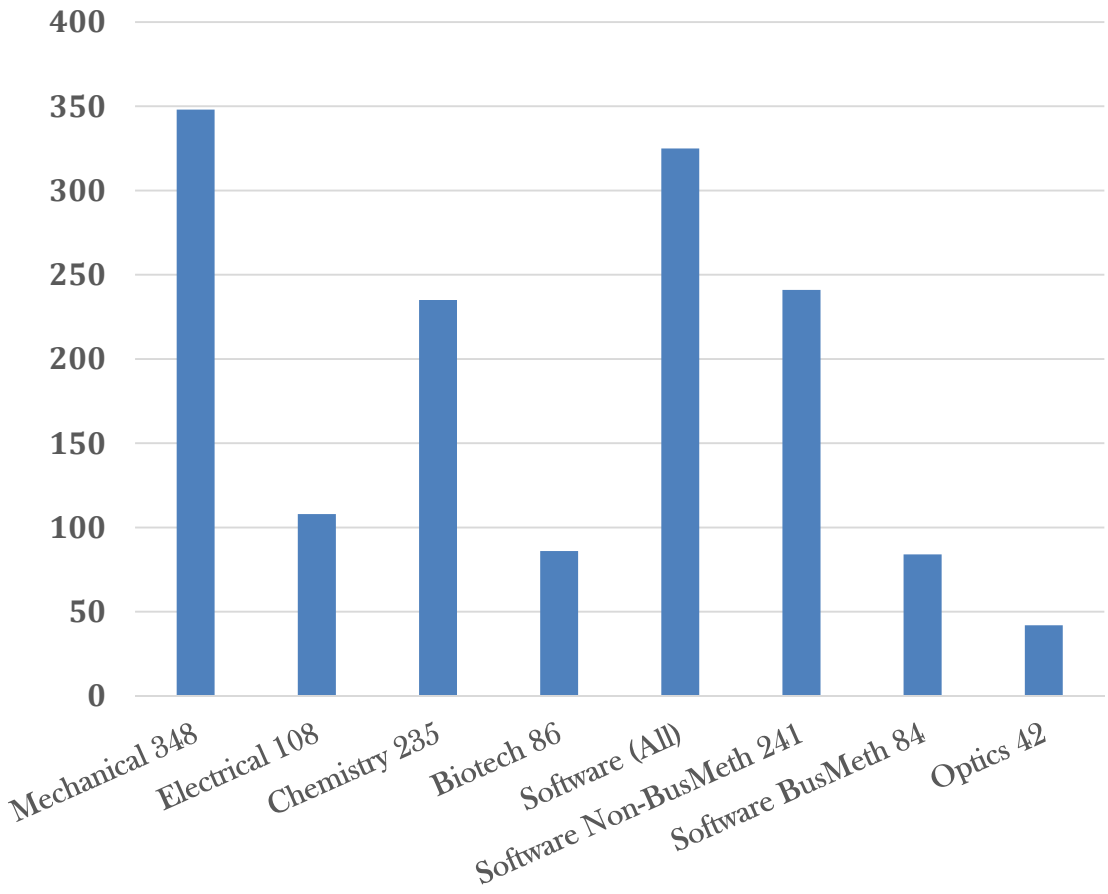
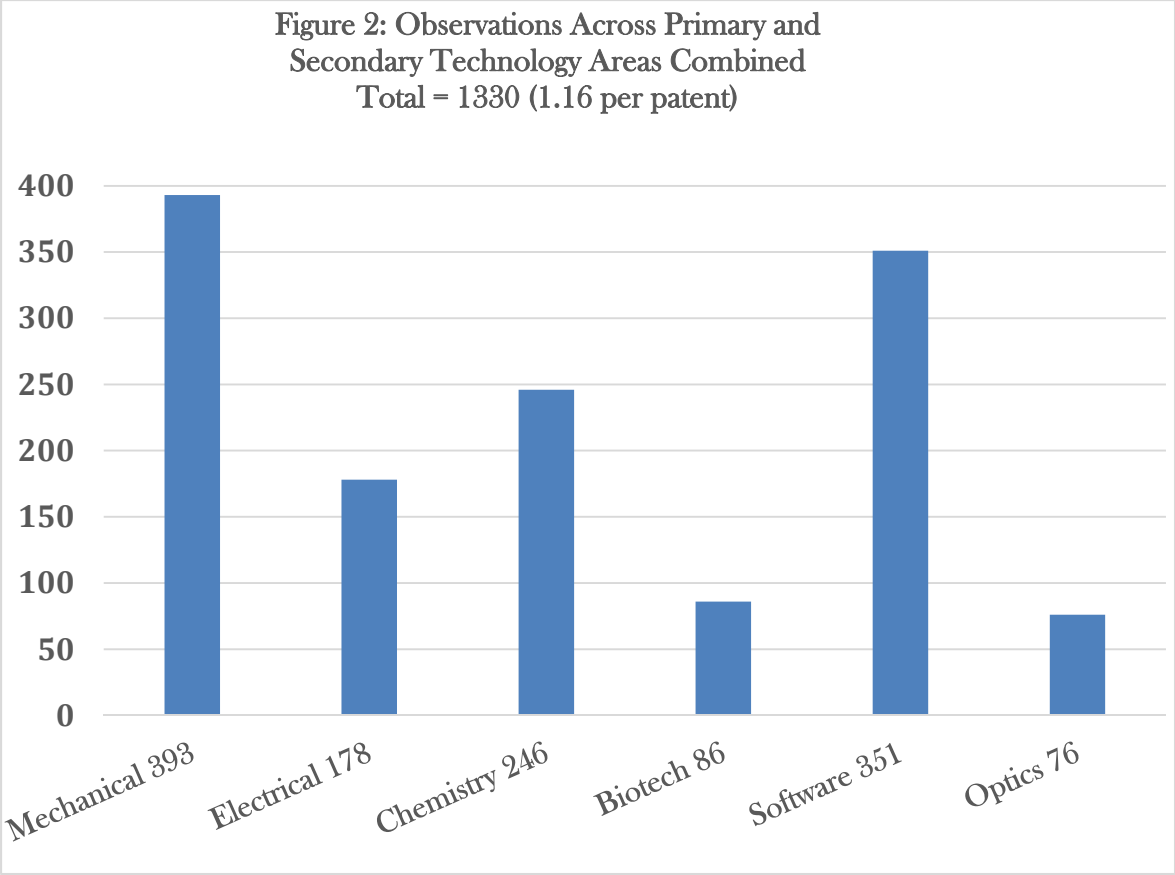
[70] We also employ the term "biotechnology" to describe an industry because the term seems to us to be the most accurate one in each case. As used here, to describe a technology, we are only concerned with scientific technique, and not with how the results of the scientific technique are ultimately employed. The scientific techniques of biotechnology can be employed in different industries. Many of the patents assigned to biotech 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 biotech produces a means for diagnosing a disease or disease propensity, the patent is properly assigned to a "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.

The numbers of observations across primary technology areas only are reported in Figure 1, which divides the software category into non-business methods software (i.e., more traditional software) and business methods. In our statistical analyses, we report on software as a whole (325 observations) compared with other primary technology areas, and then we calculate separate statistics with software divided into its two subsets, non-business methods software (241 observations) and business methods (84 observations). Figure 2 then reports the number of observations across primary plus secondary technology areas combined.

Figure 1: Observations Across Primary Technology Areas
(Software Shown Both Combined and Divided into Non-Business Methods and Business Methods)
Total = 1144





2. Industries

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 to the written description and to extrinsic evidence, especially 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. The 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 with 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 is 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 mechanical.

(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. We also divide the broad pharmaceutical industry category into subcategories for (a) cases-patent pairs in which the litigation was triggered by a generic drug manufacturer's filing of an Abbreviated New Drug Application (ANDA) under the Hatch-Waxman Act of 1984[71] and (b) those in which the litigation was not triggered by an ANDA filing. We run a separate set of regression models using the Pharmaceutical Industry category as a whole and another set of regressions in which ANDA and non-ANDA cases are treated as separate industry categories.

(4) Medical Devices, Methods, and Other Medical: This industry category includes inventions of any kind used for research on, or for the diagnosis or treatment of, diseases or other abnormal conditions in humans or animals, excluding those that are assigned to the pharmaceutical and biotechnology industry categories. Patents on processes and products for pharmaceutical purposes are not included in this category. Likewise, patents employing biotechnology techniques that purport to advance the science of biotechnology and do not cover direct medical applications are not included in this industry classification. 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. Software inventions pertaining solely to the technical aspects of communication within a computer network are not included within this category, and are placed instead in the computer & other electronics classification.

(7) Transportation (including automotive): This category includes patents on any type of invention related to the production of automobiles, trucks, aircraft, and other vehicles of any 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 sources of energy and with power generation, transportation, or consumption.

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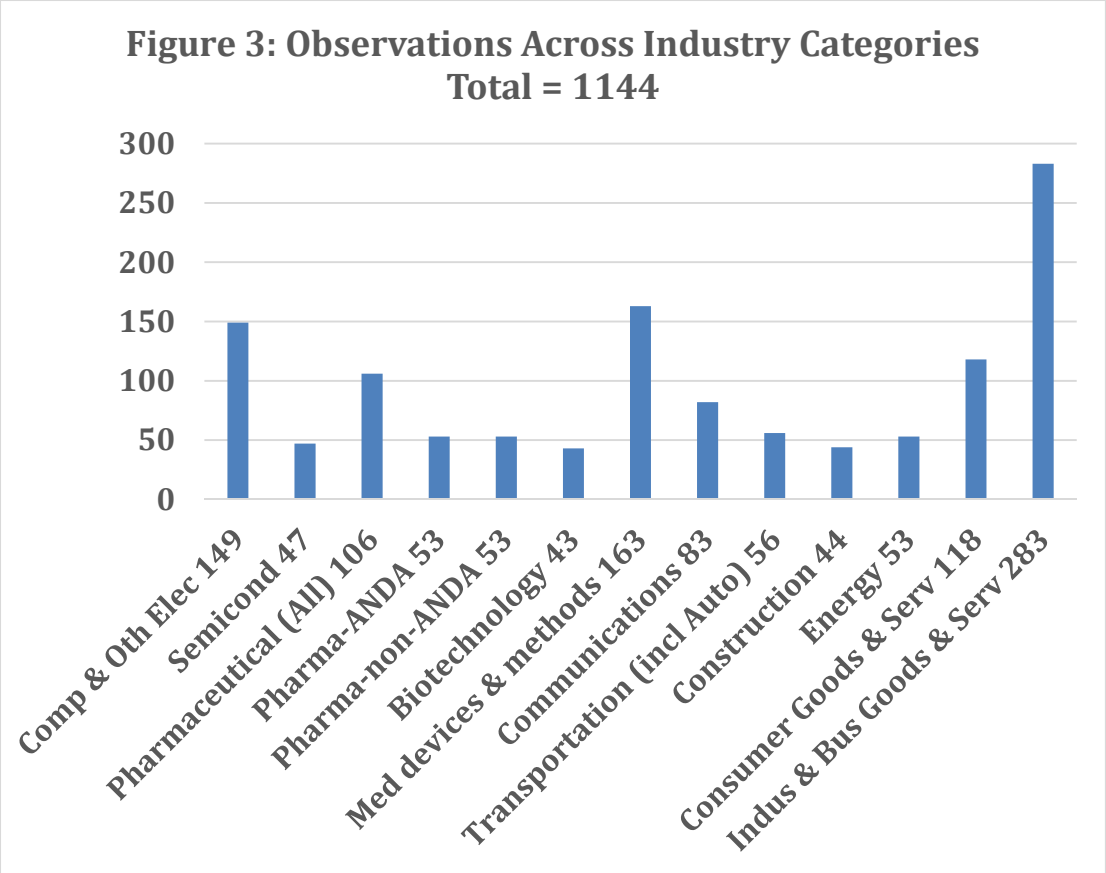
[71] Drug Price Competition and Patent Term Restoration (Hatch-Waxman) Act of 1984, Pub. L. No. 98-417, 98 Stat. 1585 (codified in scattered sections of 15, 21, and 35 U.S.C.).

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

(11) Goods & Services for Industrial & Business Uses: This category includes patents on products and services of all kinds intended for industrial and business purposes—i.e. 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.

Figure 3 reports the numbers of observations in our eleven mutually exclusive industry categories, as well as the number of cases when the Pharmaceutical industry is separated into ANDA-related cases and those not instigated as the result of an ANDA filing.



III. Results

We first describe some general descriptive statistics, followed by a report and explanation of detailed descriptive results by technology and industry. Following the discussion of descriptive results on technology comparisons, we present and discuss our regression findings and then repeat

this order of presentation for industry comparisons.

A. Descriptive Statistics

In our 1,144 case-patent pairs, there are 191 inventions with a non-U.S. origin, and 953 with a U.S. origin. This is reported as a variable in our regression results as "foreign origin." Invention origin was determined by using the following decision model: We coded a patent as having a U.S. invention origin when a majority of inventors had U.S. residences, or if there was no majority, then a plurality. A foreign invention origin was recorded using the same rule with respect to non-U.S. inventor residences. In unusual cases in which there was a tie between even counts of U.S. and non-U.S. inventor residences, the domicile of the assignee was used as a tiebreaker. As is typical, most but not all patents had an assignee-at-issue.

There are 146 instances of patents with a non-U.S. priority filing ("foreign priority"), and 998 with a U.S. priority filing. This variable and the variable for non-U.S. invention are strongly correlated positively, as one would expect, but there are a number of patents in our data set that have different invention origins and priority filing countries (often for inventions that originated in Canada or Israel but with applications that were first filed in the U.S.). Of the 146 non-U.S. priority filings, the largest number were in the UK with 38, followed by Japan with 26, Germany with 22, France with 16, and Israel with 11.

We collected only utility patents, and not design or plant patents. Only 36 of these were reissue patents, the remaining 1,178 being regular utility patents.[72] Our data set includes 354 appeals court decisions and 790 from district courts.[73] In addition, 1,022 decisions in our study were rendered after the April 5, 1995 date of the Federal Circuit's decision in *Markman v. Westview Instruments, Inc.*,[74] whereas 122 were made before that date. We discuss this case briefly and how we control for its possible effects on outcomes in this study when we report and explain the regression results.

We also coded for the federal district in which the case was filed. The three districts in which the largest number of cases were filed were the usual suspects: the District of Delaware (164), the Northern District of California (126), and the Eastern District of Texas (112). There was a large separation in numbers of filings between the top three and the remainder of the districts; the fourth busiest, the Northern District of Illinois, accounted for only 66 of the decisions.

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[72] If a patentee can prove that, because of a good faith mistake, it claimed either less than or more than its specification supported, it can apply for a reissue patent. A patent owner can seek a reissue patent with *narrower* claims at any time during the patent's term of protection, but can only seek one with *broader* claims within two years after issuance of the original patent. A reissue patent has only the term of protection that the original patent would have had. See 35 U.S.C § 251 (2012).

[73] Four early appellate decisions in our data set were by regional circuit courts. We kept these in the data set because we believed that any disparate application of § 112 requirements would likely have been found in the early 1980s.

[74] 52 F.3d 967 (Fed. Cir. 1995) (in banc), *aff'd*, 517 U.S. 370 (1996).

B. Outcomes by Technology

1. Scores on Ordinal Scales

We present basic descriptive statistics showing mean scores, with standard deviations, across technologies and industries. These results are shown for both the 5-level and the coarser 3-level scales. These raw scores are, as observed previously, measures of outcome strength in ascending order of favorability to the patent owner that do not reflect the influence, if any, of other factors. We subsequently take account of other possible influences on these outcomes in our regression models. Table 1 shows these statistics by primary technology and issue, Table 2 by primary plus secondary technology area combined.

Table 1: Scores by Primary Technology Area & Issue

		Enablement		Written Description		Claim Definiteness	
		5-level	3-level	5-level	3-level	5-level	3-level
Mechanical	N	137	137	88	88	195	195
	mean	3.847	2.540	3.398	2.341	4.364	2.733
	sd	1.143	0.707	1.335	0.786	1.266	0.643
Electrical	N	49	49	30	30	64	64
	mean	3.633	2.449	3.967	2.633	4.109	2.625
	sd	1.253	0.765	0.928	0.615	1.460	0.745
Chemistry	N	110	110	58	58	128	128
	mean	3.509	2.364	3.379	2.328	4.156	2.617
	sd	1.262	0.787	1.295	0.846	1.360	0.722
Biotechnology	N	44	44	40	40	30	30
	mean	3.341	2.295	3.150	2.150	4.300	2.700
	sd	1.293	0.851	1.460	0.864	1.393	0.702
Software (All)	N	73	73	74	74	235	235
	mean	2.918	1.863	2.959	2.027	3.877	2.451
	sd	1.256	0.805	1.409	0.793	1.719	0.868
Software (Not BusMeth)	N	60	60	50	50	173	173
	mean	2.817	1.8	3.12	2.16	3.971	2.503
	sd	1.242	0.819	1.409	0.792	1.644	0.833
Software (BusMeth)	N	13	13	24	24	62	62
	mean	3.385	2.154	2.625	1.750	3.613	2.306
	sd	1.261	0.689	1.377	0.737	1.902	0.951
Optics	N	20	20	9	9	21	21
	mean	3.100	2.150	3.222	2.111	4.238	2.667
	sd	1.334	0.813	0.972	0.782	1.446	0.730

These results show that patents in the mechanics, electrical, chemistry, biotechnology, and optics technology fields did most well in the face of claim indefiniteness challenges, with software having done less well, and software's business method subset performing most poorly. Even software-implemented business methods, however, performed at well above 3 on our 5-level scale. The mean descriptive score on claim definiteness across all technologies is a rather high 4.174, meaning that the average patent in our study contested for indefiniteness received a ruling above the level of "fact issue followed by a validity ruling."

Scores on the 3-level scale follow the same pattern on all three issues. We will not discuss 3-level descriptive results further, leaving aside the coarser scale until arriving at the regression section of this article where it has its greatest utility as a robustness check on the regression results for the 5-level scale.

Patents involving all technologies performed less well on enablement and written description than on definiteness. This may be because courts are less receptive to indefiniteness arguments, or it may reflect a reluctance to bring weaker enablement and written description challenges, perhaps due to greater costs in raising these defenses. On enablement, patents employing the oldest technology of all, mechanics, scored higher than those in any other primary technology area, and software scored the lowest. In the software area, it may come as a surprise that the non-business-method software patents did less well than those covering business models and techniques. Unlike the rest of the software class, business methods were ranked almost as high as biotech and above optics. The mean score for optics, however, may be less reliable than the scores for other categories because of smaller numbers, which were particularly small when divided into three separate issues. The mean score on enablement across the six technology areas is 3.391, which, without considering any influence on outcomes caused by factors other than technology variation, is considerably lower than the score for definiteness.

On written description, patents in the electrical and mechanical switched places, the former performing best. Software categories business methods did more poorly than any other category, followed from the bottom by non-business method software and software as a whole. Biotechnology also did worse than the all-technology mean for written description and just barely above software as a whole and non-business-method software. Optics was next, followed in ascending order by chemistry and mechanical patents. The overall mean written description score was 3.458, with electrical, mechanical, and chemistry patents falling above that mean and biotechnology, optics, and software falling below. One can see that patents across all fields did worse on enablement than on the other two § 112 requirements, although its descriptive results were not far below those of written description (averaging 3.391 compared with 3.458).

Table 2: Scores by Technology Area & Issue
Primary + Secondary Areas Combined

		Enablement		Written Description		Claim Definiteness	
		5-level	3-level	5-level	3-level	5-level	3-level
Mechanical	N	156	156	108	108	221	221
	mean	3.750	2.487	3.389	2.315	4.321	2.710
	sd	1.221	0.749	1.373	0.805	1.301	0.666

Electrical	N	81	81	48	48	100	100
	mean	3.407	2.309	4	2.688	4.040	2.560
	sd	1.292	0.785	0.875	0.589	1.550	0.795
Chemistry	N	114	114	61	61	135	135
	mean	3.518	2.377	3.393	2.344	4.156	2.615
	sd	1.243	0.780	1.269	0.834	1.365	0.723
Biotechnology	N	44	44	40	40	30	30
	mean	3.341	2.295	3.150	2.150	4.300	2.700
	sd	1.293	0.851	1.460	0.864	1.393	0.702
Software	N	85	85	81	81	252	252
	mean	3.012	1.929	3.012	2.062	3.929	2.476
	sd	1.305	0.813	1.374	0.780	1.692	0.854
Optics	N	34	34	19	19	41	41
	mean	3.147	2.088	3.421	2.211	4.268	2.683
	sd	1.306	0.793	1.346	0.787	1.361	0.687

As would be expected, the scores across our primary and secondary technology fields combined reveal patterns quite similar to those found in the primary technology areas alone, with certain exceptions. Inventions employing mechanical technologies scored highest overall across the three § 112 issues. Most inventions consisting entirely of mechanical elements, or in which mechanical elements form a critical part, involve structures and concepts that may be more easily grasped by lawyers, judges and juries than inventions in other fields. If so, this fact may contribute to the relatively greater degree of success when confronted with validity challenges of any kind based on § 112.

To help make this abstract discussion of validity by technology more concrete, below is an example of a patent claim that was coded in our "mechanical" technology category and our "medical device/methods" industry category. It illustrates that the imperfection of human language can cause difficulty in precisely describing even a purely mechanical invention—in this case, an expandable coronary stent for use in angioplasty ("balloon surgery"):

> A stent having a patterned shape comprising:
>
> (a) even first meander patterns having axes extending in a first direction;
>
> (b) odd first meander patterns having axes extending in said first direction, wherein the odd first meander patterns are 180° out of phase with the even first meander patterns, the even first meander patterns and the odd first meander patterns alternating with and spaced from each other;
>
> (c) second meander patterns having axes extending in a second direction different from the first direction, the second meander patterns being interconnected with the even and odd first meander patterns to form a generally uniform distributed structure,
>
> (d) wherein the first and second meander patterns have loops,
>
> (e) wherein the even and odd first meander patterns are interconnected to leave a

> portion of the second meander patterns in the space between adjacent even and odd first meander patterns,
>
> (f) wherein the portions of the second meander patterns between adjacent even and odd first meander patterns are adapted to lengthen and to compensate for the tendency of the loops of the first meander patterns to foreshorten when the stent is expanded and
>
> (g) wherein the first and second meander patterns are interconnected to leave only two loops of each of the first meander patterns between each pair of second meander patterns.[75]

Although this patent was not challenged on enablement or written description grounds, it was the subject of sharp disagreement over the alleged indefiniteness of a dozen different terms found in the above claim and several others, including "meander pattern," "loop," and others.[76] After concluding that none of the disputed terms had a customary meaning and that the patent owner had chosen to be "its own lexicographer" (i.e., had defined its own terms in the specification), the district court found all terms to be not indefinite as a matter of law.[77]

Mean 5-level scores on the three § 112 patentability requirements *combined* provide a somewhat different lens through which to compare the six technology areas. Table 3 reveals that, in descending order, electrical, mechanical, and chemistry did better than the all-technology mean, while biotechnology, optics, and software did worse.

Table 3: Mean Scores by Primary Technology Area Across All § 112 Requirements Combined

Mechanical	3.870
Electrical	3.903
Chemistry	3.681
Biotechnology	3.597
Software (All)	3.251
Optics	3.520
All-Tech Mean	3.637

Table 4 does the same for primary plus secondary technology areas combined. Examining the means for primary plus secondary technology fields combined across all three issues, we see that patents on mechanical and electrical technologies are all but identical, again followed by chemistry in descending order above the all-technology mean, the same three technologies falling

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[75] U.S. Patent No. 6,443,982 cl. 19 (filed Jan. 21, 2000) ("Flexible expandable stent").

[76] Medinol Ltd v. Guidant Corp., No. 03 Civ. 2604, 2004 WL 2210290, at *4-*13 (S.D.N.Y. Sept. 30, 2004).

[77] *Id.*

below the overall mean as was the case with only the primary fields. In the comparison of primary and secondary areas combined, optics scored barely below the all-technology mean, biotechnology ranking just behind, and software as a whole scoring at the bottom by what appears to be a very meaningful margin.

Table 4: Mean Scores by Primary + Secondary Technology Areas Combined Across All § 112 Requirements

Mechanical	3.820
Electrical	3.816
Chemistry	3.689
Biotechnology	3.597
Software (All)	3.318
Optics	3.612
All-Tech Mean	3.642

2. Regression Results by Technologies and Issues

From a purely descriptive perspective, the conventional wisdom that courts have applied § 112's disclosure and claim clarity requirements differently across technology fields appears to embody a degree of truth. Such a conclusion is premature, however, without using multiple regressions to test these differences while also controlling for other factors that could have influenced the outcomes. Table 5 presents summary regression findings for primary and secondary technology areas combined, and then primary areas alone, for each of the three issues: enablement, written description, and claim definiteness. All regressions used the ordered logistic regression (or ordered logit) model,[78] with standard errors calculated using the bootstrap method with clustering at the patent level.[79]

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[78] We used ordered logistic regression models because each of our dependent variables (specific outcomes on each of the three issues) is ordinal, with ordered values (ranging from 1–3 or 1–5 for the two different coding schemes) indicating the strength of the outcomes in favor of patent validity. *See generally* J. SCOTT LONG & JEREMY FREESE, REGRESSION MODELS FOR CATEGORICAL DEPENDENT VARIABLES USING STATA 186-88 (2d ed. 2005) (describing the appropriate application of ordered logit models). We used the Stata statistical analysis software package.

[79] 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 a large number of times. *See* LONG & FREESE, *supra* note 78, at 127. Additionally, data were clustered at the patent level because outcomes on the same patents in different cases are likely to be correlated. *See id.* at 85-86. For example, for each regression on enablement, we had 433 observations, divided into clusters by patent number. Stata's bootstrapping procedure first took a random sample of 433 observations from the original set based on drawing cluster units with replacement (so that observations on the same patent are always drawn together). The resulting random sample is not identical to the original 433-observation sample because the randomness of the sample will miss some of the observations and duplicate others. Stata then ran the ordered logistic regression on the random sample. This process of drawing a new random sample and running the regression was repeated 1,000 times. The coefficients from the 1,000 regressions were used to derive a final p-value and standard error for each coefficient. We followed the same

Each of the columns in the table reveals the results of a separate ordered logit regression, which includes as independent variables not only the technology area but also several other variables that could possibly influence the outcomes.[80] Only outcomes measured by the 5-level scale are reported in Table 5; such outcomes on the coarser 3-level scale are included in the Appendix along with other more detailed findings.

In the table, coefficients appear first; in parentheses just below each coefficient is the corresponding p-value, which indicates how significant the results are.[81] For example, p=0.05 indicates that there is only a 5% chance that the sign of the coefficient is simply due to chance. A highly significant result simply indicates that there is a non-random difference between that group of patents and other patents in the sample; it says nothing about whether that difference is large or practically significant. For that, it is necessary to examine the magnitude of the coefficients.[82] In our regressions, positive coefficients indicate that patents in that category were more likely to survive validity challenge than the unreported "comparison dummy"—here, patents in the optics technology category. Negative coefficients indicate that patents in that category fared less well. Comparing coefficients for two reported technologies indicates how they fared relative to each other. Note that the relative ordering of the coefficients will not change depending on which is chosen as the comparison group, but their statistical significance—which is measured relative to the comparison group—may change. After Table 5, we explain these results in detail, including the independent variables we introduced as controls for the influence of factors other than just the technology areas. We later do the same for industries.

Table 5. Ordered Logit 5-Level Outcomes by Primary Technology Field

	Enablement		Written Description		Claim Definiteness	
	combined	primary	combined	primary	combined	primary
mechanical	0.368	1.099**	0.176	0.370	0.259	0.0406
	(0.283)	(0.0226)	(0.649)	(0.504)	(0.488)	(0.974)
electronics	-0.0559	0.864*	1.221***	1.217**	-0.0525	-0.180
	(0.866)	(0.0938)	(0.000726)	(0.0373)	(0.866)	(0.886)
chemistry	-0.0850	0.616	0.0934	0.212	-0.0337	-0.284
	(0.821)	(0.197)	(0.836)	(0.711)	(0.934)	(0.818)
biotechnology	-0.141	0.556	0.0386	0.182	0.382	0.125

procedure separately for the written description and claim definiteness issues, the size of each resampling being the number of observations for that particular issue (i.e., 299 and 673, respectively). Also, separate regressions using identical techniques were run for the 5-level and 3-level models on each issue.

[80] More detailed regression findings are reported in the Appendix, including the results from our use of "parsimonious" models without the controls we report in the body of this article, as well as other ordered logit results at a finer level. There were few changes in the magnitude or statistical significance of coefficients for technologies or industries between the parsimonious models and ones with the added controls.

[81] Standard errors for all coefficients are in our files. Because the standard error can be easily calculated from the coefficient and the p-value, we chose to not report them separately in this paper.

[82] The coefficients are actually log-likelihood ratios. For a basic overview of interpretation of ordered logistic regression coefficients, see *Stata Annotated Output: Ordered Logistic Regression*, UCLA STATISTICAL CONSULTING GRP., http://www.ats.ucla.edu/stat/stata/output/stata_ologit_output.htm (last visited Jan. 14, 2015).

	(0.744)	(0.287)	(0.939)	(0.766)	(0.609)	(0.923)
software: bus. meth.	-0.246	0.475	-0.842	-0.727	-0.138	-0.407
	(0.721)	(0.535)	(0.161)	(0.269)	(0.783)	(0.749)
software: not bus. meth.	-1.002***	-0.450	-0.269	0.0677	0.326	-0.0290
	(0.00533)	(0.384)	(0.449)	(0.910)	(0.394)	(0.981)
MPF claim element					-1.659***	-1.610***
					(1.17e-08)	(1.14e-08)
reissue patent	-0.309	-0.260	0.908	0.926	0.376	0.378
	(0.511)	(0.586)	(0.296)	(0.130)	(0.764)	(0.745)
declaratory judgment	0.110	0.137	0.318	0.196	-0.275	-0.283
	(0.686)	(0.605)	(0.445)	(0.624)	(0.332)	(0.279)
district court decision	0.662***	0.647***	0.101	0.0711	0.475**	0.483**
	(0.00353)	(0.00439)	(0.684)	(0.772)	(0.0263)	(0.0278)
foreign origin	1.041	1.000	0.0489	0.281	1.460	1.443
	(0.151)	(0.175)	(0.909)	(0.497)	(0.510)	(0.401)
foreign priority	-0.441	-0.367	0.467	0.176	-1.872	-1.831
	(0.583)	(0.648)	(0.349)	(0.718)	(0.398)	(0.287)
post-*Markman*	-0.286	-0.278	0.134	0.176	0.660***	0.686***
	(0.248)	(0.290)	(0.661)	(0.575)	(0.00538)	(0.00416)
E.D. Tex.	-0.688	-0.679	-0.394	-0.0847	-0.147	-0.0820
	(0.219)	(0.227)	(0.541)	(0.888)	(0.674)	(0.811)
N.D. Cal.	-0.328	-0.344	-0.208	-0.281	0.411	0.398
	(0.233)	(0.222)	(0.557)	(0.429)	(0.222)	(0.207)
D. Del.	-0.160	-0.189	0.376	0.309	-0.175	-0.168
	(0.555)	(0.487)	(0.197)	(0.279)	(0.473)	(0.485)
N	433	433	299	299	673	673

Values in parentheses are p-values, with *** p<0.01, ** p<0.05, * p<0.1. All regressions use the ordered logit estimator. The unspecified comparison technology variable is optics.

Confirming the descriptive results we observed, patents on inventions in the primary mechanical technology area did significantly better than other areas in withstanding enablement challenges (p<0.05), although primary plus secondary technology areas combined revealed no such advantage over other combined fields.

Again substantiating the descriptive results, electronics patents revealed significant comparative strength on written description in the primary technology areas (p<0.05), and highly significant comparative strength in primary plus secondary areas combined (p<0.00l). Patents in the primary electronics technology field, but not primary combined with secondary, also performed better than those in other primary technology areas on enablement, but only at a p<0.10 level. When data are characterized by a lot of noise in the form of undiscoverable or unmeasurable explanatory variables, which is surely true of data on specific litigation outcomes such as ours, it may be worth noting a finding at even this marginal level of significance.

Interestingly, we found no significant differences for either the chemistry or biotechnology tech areas on any of the disclosure or definiteness requirements. Surprisingly, the same was true

for the software business methods subset, but patents on more traditional software inventions that were not business methods showed highly significant weakness on enablement. This comparative weakness was found, however, for only the primary plus secondary software non-business methods combined category ($p<0.01$), and not for the primary one alone, thus perhaps softening this finding. The inventions assigned to the *secondary* software non-business methods technology class apparently happened to have been paired with those that did poorly on enablement in other primary technology fields. It is noteworthy, however, to discover that courts were more likely to hold any grouping of software patents invalid for enablement. Again, however, the finding is a weak one.

As controls on the regression results for outcomes on the three § 112 issues by technology, we included the following variables:[83]

(1) *Whether the claim element at issue was in "means plus function" (MPF) format.* Such format is, simplistically stated, one in which the drafter merely claimed a "means" for achieving a specified function without also claiming any corresponding structure or steps for accomplishing the function. Thus, "means for transforming a toad into a charming prince" is drafted in MPF format. Under § 112(f) (formerly § 112 ¶ 6), MPF claims are allowed *only if* the structure required for accomplishing that function is clearly described in the specification.[84] If a litigant argues that a disputed claim term is in MPF format, the district court must first determine whether this is true; if it is, the court must then determine whether the claimed function is adequately supported in the specification by the clear expression of some type of structure, whether that structure be an electrical circuit, a seal to prevent impurities from intruding into a cylinder that contains a piston, or an algorithm for accomplishing a data processing function. The above is important to our study because a claim definiteness issue is inherent in any decision finding that a claim element is in MPF format, because an MPF claim without a description of sufficient structure in the specification requires a finding of claim indefiniteness under § 112(b).[85] Consequently, we include this variable as a control, but only in the ordered logit models for the claim definiteness issue.[86] The negative and very highly significant coefficients for both primary and primary-plus-secondary technology field comparisons reveals that a claim with an MPF element was far more likely to succumb to an indefiniteness challenge ($p<0.001$).

(2) *Whether the patent was a reissue.* Because the grant of a petition for a reissue patent requires the patent owner to surrender the original patent, thus leaving it vulnerable to any objection to its continued validity by the PTO, one may naturally wonder whether a patent emerging from this process might be less susceptible to validity challenges in subsequent litigation.

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[83] There are many other possibilities of things we could have controlled for, such as number of citations to the patent, age of the patent at the time of filing, or average number of defendants. Given the difficulties with introducing too many variables, we focused on those controls that seemed most likely to affect litigation outcomes based on prior studies.

[84] 35 U.S.C § 112(f) (2012) ("An element in a claim for a combination may be expressed as a means or step for performing a specified function without the recital of structure, material, or acts in support thereof, and such claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof.").

[85] 35 U.S.C. § 112(b); *see* Robert Bosch, LLC v. Snap-On Inc., 769 F.3d 1094, 1097 (Fed. Cir. 2014).

[86] There is a large body of literature on MPF claims, including much analysis of whether courts have adopted the correct approach in determining whether a claim element is in MPF format in the first place. *See, e.g.*, Lemley, *supra* note 47. The subject is, of course, quite beyond the scope of this article.

We thus identified all reissue patents in our data set, and included its status as a reissue as a control in our regression models. As an independent variable, it showed no significant effect on any of the three § 112 issues in any technology field.

(3) *Whether the case was initiated as a declaratory judgment action.* Prior research by one of the present authors revealed that accused infringers fare significantly better on several issues in patent litigation when they institute the action by filing for a declaratory judgment of noninfringement and invalidity, even after controlling for any effects that may have been caused by the ability to choose which federal district in which to institute the action.[87] Because of this evidence, we controlled here for who filed the action first. The coefficient on this control variable was not statistically significant in any of our technology regressions, although lack of a finding of significance does not indicate that there is no effect—just that we cannot statistically demonstrate such an effect with this dataset. The prior study and the present one had fundamentally different objectives, the data sets were very different, the outcomes studied were different, and the coding scheme for outcomes was different.[88] Consequently, whether "who goes first" makes a real difference in outcomes remains a viable question meriting further research.

(4) *Whether the last decision was rendered by a district court.* Identifying those cases in which the last decision was made by a district court provides an opportunity to examine whether district courts as a group or the Court of Appeals for the Federal Circuit display noticeably different tendencies when deciding disclosure and definiteness issues. There have been assertions that the Federal Circuit possesses a pro-patent bias leading it to hold patents to be valid with greater regularity than the district courts that it supervises.[89] Although district courts naturally tend to follow the Federal Circuit's dictates out of concern for reversal if nothing else, we found the reverse to be true for enablement and definiteness. Our regression results show that, while taking into account the effects of technologies, disparities across districts, and other factors of possible influence, district courts as a group are more likely to uphold patents in the face of an enablement challenge with a high degree of significance ($p<0.01$), and more likely to find patents valid in the face of an indefiniteness allegation at a very significant level ($p<0.05$). These p-values were for primary plus secondary technology areas combined, but the Appendix shows that the results are virtually identical in the model for primary technology fields alone. Our finding that district courts were much more strongly inclined than the Federal Circuit to uphold patents against enablement and indefiniteness is an important one, but its limitation to only two specific patent validity issues obviously precludes any broad statement. It may signify, however, that the question of district court vs. Federal Circuit tendencies bear a closer empirical look, because of the large number of unappealed district court decisions.

(5) *Whether the patented invention originated outside the U.S.* We previously discussed

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[87] Allison et al., *Realities of Modern Patent Litigation*, *supra* note 5, at 1797-98 (studying very specific litigation outcomes using a data set of 949 case-patent pairs for cases filed during 2008-2009 resulting in a merits outcome by the end of 2013).

[88] *Id.* That study used a data base including only cases filed in 2008-2009 that resulted in merits decisions by the end of 2013, examined outcomes on far more issues in addition to overall case outcomes, separately coded decisions at all procedural levels, and coded each outcome in a very different manner. The objectives of the two studies were completely different.

[89] *See* ADAM B. JAFFE & JOSH LERNER, INNOVATION AND ITS DISCONTENTS: HOW OUR BROKEN PATENT SYSTEM IS ENDANGERING INNOVATION AND PROGRESS, AND WHAT TO DO ABOUT IT 104-05 (2004).

the manner in which we made this determination. Including this variable as a control on the regression results, as well as reporting its coefficient as an independent variable, seeks to answer the question whether there is something about United States patents covering that originated in another country that is different in a way that affects compliance with any of the § 112 requirements. Recent research revealed that foreign-origin patents did significantly better on several important issues than their U.S.-origin counterparts in American patent litigation.[90] In the present study, however, we found no significant effects on any of the § 112 outcomes in any technology field.

(6) *Whether the patent had a non-U.S. ("foreign") priority filing*. Our goal in coding for whether the application for a patent in our data set was originally filed outside the U.S. and using it as a control in our regression models is the same as that for using foreign invention origin as a variable. As with foreign invention origin, a foreign priority filing had no significant effect on any of the three § 112 outcomes.

(7) *Whether the decision occurred after the Federal Circuit's* Markman *decision.* The decision of the Federal Circuit in *Markman v. Westview Instruments*,[91] affirmed the next year by the Supreme Court,[92] affected patent litigation as fundamentally as any ruling in the modern era by mandating that claim construction—interpretation of disputed language in patent claims—is the sole province of the court and must not be performed by juries. Claim construction is a prerequisite to all infringement and validity decisions, as the court must ascertain the exact contours of the patented invention before being able to decide or instruct a jury about either. Among other things, *Markman* greatly increased the focus on the claims in a patent, which not only brought indefiniteness allegations by defendants to the front and center of each case when there is any reasonable basis for such an allegation. The importance of *Markman* is far from being limited to questions about definiteness, however, because what the claims are finally determined to mean influences decisions on enablement and written description questions, as well. It is the claims, as interpreted, that must be enabled by the specification, and it is likewise the claims, as interpreted, that must describe an invention clearly envisioned by the inventors in that specification. One might say, then, that *Markman* brought all § 112 issues to the fore. An eponymous *Markman* hearing takes place after at least some pretrial discovery has been completed in practically every patent infringement case, the sole objective of which is construction of disputed claim terms based on evidence and arguments presented by the litigants. A district judge sometimes even makes decisions about claim definiteness (as a matter of law, naturally) in the claim construction order, although many judges eschew this practice and decline to render definiteness decisions before trial only in response to summary judgment motions. Our ordered logit regression models control for any post-*Markman* effects on all of the decisions in our data set.[93] Holding all other variables constant, including technology area, decisions rendered after the date of the Federal Circuit's *Markman* decision did not affect outcomes on either enablement or written description, but did show a highly significant effect on 5-level claim definiteness outcomes. Patents claims were much

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[90] *Id.* at 1796-97. Again, the two studies are very different in several fundamental respects.

[91] 52 F.3d 967 (1995).

[92] 517 U.S. 370 (1996).

[93] A patent-case pair is coded with a "1" if the decision occurred after April 5, 1995, and "0" if the decision occurred before that date.

more likely to have been found definite ("not indefinite") in cases decided after *Markman* than before ($p<0.01$).

(8) *The district in which the case was filed.* Patent law commentators have debated for some time whether the federal district in which a patent litigated files its lawsuit matters to the suit's outcome.[94] Prior research does reveal some differences across districts. For example, a recent study in which one of the present authors participated found the following: Among the thirteen "busiest" federal districts for patent cases, patent owners were significantly more like to win a case on all infringement and validity issues combined in the Eastern District of Texas, the District of Delaware, and the Southern District of New York. On the other hand, patent owners were significantly less likely to achieve such a "definitive win" in the Central District of California and the Northern District of Illinois.[95] Here, the degrees of freedom permitted by our sample size and total number of dependent and independent variables led us to conclude that we should control for "district effects"—variations by district when other factors are held constant—by including dummy variables for our three "busiest" federal districts as controls, all other districts combined serving as the comparison dummy for district comparisons. Because the three top districts in our data set account for over 400 of the 1,104 patent-case pairs, we believed that if there were any significant district effects on our results, they would stand a good chance of being revealed.[96] As previously noted, the three districts found to have heard the most § 112 cases during the thirty-year period of our study were the District of Delaware, the Northern District of California, and the Eastern District of Texas. A case having been filed in any of these three districts had no statistically significant effect on enablement, written description, or claim definiteness outcomes. Again, this does not mean that there is no effect; it only means that we were unable to isolate an effect using our dataset. But the real importance of having variables for the top three districts is to control for any possible district effects on § 112 outcomes across technology areas, and not to show specific variations among districts.

C. Outcomes by Industry

1. Scores on Ordinal Scales

We performed the same descriptive analyses of outcomes by industries as we did by technologies, although the industry categories are all mutually exclusive and not separated into primary and secondary areas. As explained previously, we separated the Pharmaceutical industry category into two subgroups: one containing patents in ANDA-related litigation and the other with patents in litigated not catalyzed by a generic drug maker's filing of an ANDA. Table 6 articulates 5-level and 3-level N's, mean scores, and standard deviations for the three § 112 issues by industry.

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[94] *See, e.g.*, J. Jonas Anderson, *Court Competition for Patent Cases*, 163 U. PA. L. REV. (forthcoming 2015), *available at* http://ssrn.com/abstract=2491077 (arguing that courts such as the Eastern District of Texas have favored plaintiffs in order to attract new patent cases).

[95] Allison et al., *Realities of Modern Patent Litigation*, *supra* note 5, at 1790-95. The authors also cite and discuss other research on the question of whether the federal district in which a case is filed really matters. *Id.*

[96] Were it possible, we would have preferred to include variables for a larger number of districts.

Table 6: Scores by Industry & Issue

		Enablement		Written Description		Claim Definiteness	
		5-level	3-level	5-level	3-level	5-level	3-level
Computer & Other Electronics	N	32	32	30	30	102	102
	mean	2.563	1.594	3.067	2.133	4.108	2.559
	sd	1.162	0.837	1.337	0.860	1.604	0.803
Semiconductor	N	26	26	15	15	22	22
	mean	3.385	2.269	4.133	2.800	4.045	2.682
	sd	1.023	0.724	0.743	0.414	1.362	0.716
Pharmaceutical (All)	N	49	49	24	24	60	60
	mean	3.429	2.306	2.917	2	4.083	2.567
	sd	1.339	0.871	1.018	0.885	1.357	0.722
Pharmaceutical (ANDA)	N	30	30	12	12	27	27
	mean	3.6	2.4	3.5	2.5	4.704	2.889
	sd	1.329	0.855	0.798	0.798	0.669	0.32
Pharmaceutical (Not ANDA)	N	19	19	12	12	33	33
	mean	3.158	2.158	2.333	1.5	3.576	2.303
	sd	1.344	0.898	0.888	0.674	1.562	0.847
Biotechnology	N	22	22	20	20	16	16
	mean	3.455	2.364	3.050	2.100	4.875	3
	sd	1.184	0.790	1.468	0.852	0.342	0
Medical devices & methods	N	73	73	61	61	74	74
	mean	3.562	2.411	3.115	2.180	4.095	2.608
	sd	1.213	0.704	1.415	0.827	1.482	0.755
Communications	N	21	21	17	17	59	59
	mean	3.667	2.381	3.118	2.176	3.831	2.458
	sd	1.238	0.805	1.616	0.951	1.724	0.877
Transportation (incl. Auto)	N	14	14	14	14	39	39
	mean	3.071	2.143	3.429	2.214	4.410	2.718
	sd	1.542	0.864	1.399	0.699	1.371	0.686
Construction	N	16	16	9	9	28	28
	mean	3.750	2.500	3.667	2.556	4.250	2.679
	sd	1.065	0.816	1.225	0.726	1.430	0.723
Energy	N	22	22	11	11	36	36
	mean	3.818	2.636	3.273	2.364	4.472	2.778
	sd	1.296	0.727	1.272	0.809	1.183	0.591
Consumer Goods & Services	N	37	37	29	29	82	82

	mean	3.973	2.514	3.897	2.552	4.195	2.622
	sd	1.142	0.651	1.205	0.686	1.461	0.748
Industrial Goods & Services	N	121	121	69	69	155	155
	mean	3.537	2.364	3.333	2.246	3.994	2.535
	sd	1.285	0.796	1.347	0.793	1.573	0.816

Because there are eleven industry categories, twelve with the separation of the pharmaceutical category into its ANDA and non-ANDA subsets, numbers of observations in each are necessarily smaller and the scores possibly less reliable than they were for the six technology areas. That said, they should be viewed more cautiously in purely descriptive form. Multiple regression, namely, the ordered logit models we employed, take sample size into account along with other factors and therefore present a more reliable picture. On the other, hand, these descriptive statistics are not useless and are interesting in several respects.

When examining the 5-level scores by industry category, we again find higher average scores on claim definiteness than on the other two issues, which stands to reason since these are the same patents challenged for indefiniteness as in the technology areas. Industry comparisons are, however, an entirely different thing. Biotechnology industry patents, which as earlier explained include patents from the biotechnology technology area on inventions purporting to advance the science of biotech itself rather than claiming to have direct application to the pharmaceutical or medical device/methods industries, survived indefiniteness assertions better than those in other industries. However, the unusually high score of 4.875 was based on only sixteen observations and is consequently more susceptible to both selection effects and outliers. We will not continue to offer caveats about numbers of observations that are necessarily smaller than in our technology categories. The N's are in Table 5.

We report results for the pharmaceutical industry as a whole and then divided into those patents that were litigated as the result of ANDA filings by generic drug manufacturers and those litigation of which was instituted by owners without an ANDA having been filed by the potential infringer. Patents in ANDA-related litigation survived contests over claim definiteness remarkably well, with a 5-level score of 4.704, just below that experienced by patents the biotechnology industry. This performance stands in stark contrast with that of pharmaceutical patents in non-ANDA litigation, which did more poorly than any other industry grouping against assertions of indefiniteness. The definiteness chasm between patents in ANDA and non-ANDA pharmaceutical litigation may be due at least in part to the fact that patents involved in the former were more likely to cover compositions than those in the latter portion of the pharmaceutical industry category. These patents also are likely to have far more private economic value to their owners than many other kinds of patents.[97] Energy, transportation, and construction industry patents, in descending

[97] There is both widely held belief and supporting evidence that the average patent on pharmaceutical compositions has more value than does the average patent in other industries, and that patent protection is more important in this field than in others. For example, one study of 100 randomly selected firms found that patents were "essential for the development or introduction of 30 percent or more of the inventions in only two industries—pharmaceuticals and chemicals." Edwin Mansfield, *Patents and Innovation: An Empirical Study*, 32 MGMT. SCI. 173, 174 (1986). A later study by Levin and his colleagues found that, based on 650 completed questionnaires from industrial research managers, "[i]n only one industry, drugs, were product patents regarded by a majority of respondents as strictly more

order, likewise scored higher than the all-industry mean of 4.214, while patents in the consumer goods/services and computer/other electronics industries were barely below the mean, and others such as semiconductor and industrial goods/services industry patents performed below the all-industry mean, communications industry patents being next to the bottom just ahead of the woefully performing non-ANDA Pharmaceutical patents on definiteness.

On the enablement requirement, patents on consumer goods & services scored the highest, followed closely by energy and construction. Also above the all industry enablement mean of 3.474 were communications, ANDA-related pharmaceuticals, medical devices & methods, and industrial goods & services. Below the mean in descending order were biotechnology, semiconductor, non-ANDA pharmaceutical, and transportation, with computer & other electronics well back at the bottom of the list.

The across-industry mean for the written description requirement, at 3.364, was slightly below that for enablement. We find some of the same industries above and some of the same below the all-industry mean, but there are enough differences at all levels to make it clear that courts treat the two patent disclosure requirements quite differently. Semiconductor industry patents as a group score highest on written description, and the non-ANDA pharmaceutical group again ranked lowest, although the range between top and bottom is not as extreme as it was in the case of enablement. Construction industry patents again did well, as did ANDA-related pharmaceuticals, and those in the computers/other electronics industry again did relatively poorly. Other industry groups were scattered around the all-industry mean.

In Table 7, we take the same broad look at overall § 112 performance by Industry that we did by technology. Consumer goods & services, ANDA-related pharmaceuticals, energy, and construction are the best performers, while computers & other electronics and non-ANDA pharmaceuticals are by far the worst performers on the invention disclosure and claim definiteness requirements combined, the other industries hovering around the all-industry mean.

Table 7: Mean Scores by Industry
Across All § 112 Requirements

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effective than other means of appropriation," and they described pharmaceuticals as "one of the few [industries] in which patents really do seem to matter." Richard C. Levin, Alvin K. Klevorick, Richard R. Nelson & Sidney G. Winter, *Appropriating the Returns from Industrial Research and Development*, 1987 BROOKINGS PAPERS ON ECON. ACTIVITY 783, 796, 824. In a later survey of R&D managers with 1478 respondents, Cohen and his colleagues similarly found that the pharmaceutical industry was one of the few places "where patents are effective." Wesley M. Cohen, Richard R. Nelson & John P. Walsh, *Protecting Their Intellectual Assets: Appropriability Conditions and Why U.S. Manufacturing Firms Patent (or Not)* 23, 32 tbl.1 (Nat'l Bureau of Econ. Research, Working Paper No. 7552, 2000), available at http://www.nber.org/papers/w7552.pdf.

See also Lisa Larrimore Ouellette, *How Many Patents Does it Take to Make a Drug? Follow-On Pharmaceutical Patents and University Licensing,* 17 MICH. TELECOMM. & TECH. L. REV. 299 (2010). Ouellette observed that, "although [the latest of the above-referenced] surveys is more than ten years old, the importance of patents to the pharmaceutical industry has not abated," citing Jay Kesan for the proposition that that the comparative value of each patent is much higher in the life sciences than in engineering fields and that patents are not important for technology transfer in most fields other than pharmaceuticals and biotechnology). *Id.* at 303 (citing Jay P. Kesan, T*ransferring Innovation*, 77 FORDHAM L. REV. 2169, 2195 (2009)). Moreover, pharmaceutical companies spend more money on lobbying than any other industry—over $200 million in 2007—much of which is devoted to maintaining a strong patent system. Jay P. Kesan & Andres A. Gallo, *The Political Economy of the Patent System*, 87 N.C. L. REV. 1341, 1353, 1359-61 (2009).

Computer & Other Electronics	3.246
Semiconductor	3.854
Pharmaceutical (All)	3.476
Pharmaceutical (ANDA)	3.935
Pharmaceutical (Not ANDA)	3.022
Biotechnology	3.793
Medical devices & methods	3.591
Communications	3.539
Transportation (incl. Auto)	3.637
Construction	3.889
Energy	3.854
Consumer Goods & Services	4.022
Industrial Goods & Services	3.621
Mean	3.684

The mean score for all industries across all three § 112 requirements of 3.684; on our 5-level scale, this falls between "3—fact issue remaining" and "4—fact issue followed by a ruling of validity." It would be interesting indeed to know how other patentability requirements compare with those mandated by § 112 when scored on our 5-level scale; it may be possible to see how the presumption of validity for granted patents is applied in practice across different doctrines.[98]

Five industry categories score above the 5-level mean for the combination of disclosure and definiteness requirements. In descending order with little separation between them, they are consumer goods & services, ANDA-related pharmaceutical, construction, semiconductor, energy, and biotechnology. The seven industries below the all-industry mean on all § 112 issues are, again in descending order, with little separation between the first five of these, are transportation (incl. automotive), industrial/business goods & services, medical devices & methods, communications, and pharmaceutical (all). There is then a considerable drop to computer & other electronics, and an even more pronounced decline to non-ANDA pharmaceutical at the bottom of the heap.

2. Regression Results by Industries and Issues

Table 8 shows results from the ordered logit regression models on industries. We separated pharmaceutical industry patents in ANDA and non-ANDA categories, and of course

[98] Under 35 U.S.C. § 282(a), patents are presumed valid, and this presumption can only be overcome by "clear and convincing evidence." Microsoft Corp. v. i4i Ltd. P'ship, 131 S. Ct. 2238 (2011).

could not also included the pharmaceutical group as a whole as we did in our report of descriptive statistics because the subgroups are subsets of the whole. In the comparisons among industry groups, we used industrial/business goods and services (which is goods and services for wholesale purposes) as the comparison dummy. Although results for the other industries are presented in in juxtaposition with the comparison dummy, one can also compare the coefficient for each industry against those of all the industries.

Table 2. Ordered Logit 5-Level Outcomes by Industry

	Enablement	Written Description	Indefiniteness
computer & other electronics	-1.623*** (0.000277)	-0.236 (0.592)	0.265 (0.428)
semiconductor	-0.220 (0.518)	1.085** (0.0333)	0.0589 (0.883)
pharma: ANDA	0.0905 (0.841)	0.155 (0.720)	0.722 (0.537)
pharma: non-ANDA	-0.428 (0.397)	-1.214*** (0.00128)	-0.682** (0.0466)
biotech	0.0277 (0.946)	-0.140 (0.824)	1.194 (0.793)
medical devices & methods	0.0212 (0.946)	-0.268 (0.538)	-0.0512 (0.868)
communications	0.125 (0.808)	-0.371 (0.664)	0.111 (0.741)
transportation (incl. auto)	-1.043 (0.184)	0.298 (0.743)	0.667 (0.204)
construction	0.0853 (0.876)	0.593 (0.480)	0.269 (0.753)
energy	0.702 (0.179)	-0.327 (0.558)	0.249 (0.713)
consumer goods & services	0.667 (0.133)	0.987** (0.0477)	0.175 (0.561)
MPF claim element			-1.611*** (6.46e-09)
reissue patent	-0.192 (0.694)	0.340 (0.615)	0.364 (0.670)
declaratory judgment	0.523* (0.0906)	0.344 (0.423)	-0.200 (0.438)
dist. ct. decision	0.614** (0.0134)	-0.0269 (0.919)	0.453** (0.0389)
foreign origin	1.343* (0.0610)	0.414 (0.344)	1.487 (0.411)
foreign priority	-0.747 (0.349)	0.152 (0.769)	-1.778 (0.326)
post-*Markman*	-0.315 (0.226)	-0.547* (0.0647)	0.541** (0.0199)
E.D. Tex.	-0.640 (0.245)	0.210 (0.775)	-0.0510 (0.876)
N.D. Cal.	-0.316	-0.0288	0.374

	(0.269)	(0.944)	(0.230)
D. Del.	-0.136	0.432	-0.114
	(0.661)	(0.178)	(0.655)
observations	433	299	673

Values in parentheses are p-values, with *** p<0.01, ** p<0.05, * p<0.1. All regressions use the ordered logit estimator. The unspecified comparison industry is goods & services for industrial and business purposes.

Computer and other electronics industry patents were far less likely to survive enablement contests than other industry groups, but this industry did not differ significantly from others on written description or definiteness. Patents in the semiconductor industry did significantly better than the industry norm on written description, and although ANDA-related pharmaceutical patents showed no significant differences from other industries on any of the three issues, non-ANDA pharmaceuticals performed quite poorly on written description and definiteness. The biotech, medical, communications, transportation, construction, and energy industries did not differ significantly from other industries on any of the issues, while consumer goods and services performed better than the others on written description.

As was the case with regression results for technology comparisons, our ordered logit models revealed only a few differences among industries. In both technologies and industries, there were a few notable instances of § 112 outcome variations, but the overall picture is one of more similarity than dissimilarity on disclosure and definiteness requirements when the possible effects on outcomes of district variations and a number of other variables are neutralized.

We introduced the same control variables in our industry logit models as we did with the technology models, and a discussion of those variables will not be repeated. Some of the individual findings on these variables are interesting, but most of them had little effect on judicial application of § 112 requirements. One notable exception, which had been revealed in the technology regression results and appears again in the industry results, was that the fact of a disputed claim term being in MPF format greatly decreased the odds of a favorable ruling on definiteness ($p<0.01$). A case having been instituted as a declaratory judgment, which had no significant effect in the technology regressions, had only a marginally significant effect on enablement rulings ($p=0.10$) in the industry regressions; interestingly, the positive coefficient means that the patent owner was slightly more likely to succeed on enablement when the potential infringer had preemptively sued seeking a declaratory judgment. And, as we saw in our technology regressions, here we found that district courts were significantly more likely than the Federal Circuit to favor patent owners on enablement and definiteness ($p<0.05$, the actual p-value on enablement being quite close to being significant at the $p<0.01$ level). Patents on foreign-origin inventions fared slightly better on enablement than did their American-origin counterparts ($p<0.10$), and those patents litigated after *Markman* performed significantly better on definiteness than they did before M*arkman*. Patents in post-*Markman* cases did slightly worse ($p<0.10$), however, on written description than they did prior to that time. As with our technology logit models, we again found no district effects in the results for industry models.

D. Summary: Does the Subject Matter of Patents Really Matter in § 112 Decisions?

Among technology groups, patents on inventions in the older fields of electronics,

mechanics, and chemistry performed solidly on our descriptive measures. Descriptively, software business method patents did much better on § 112 requirements than most observers probably would have supposed, but software patents covering inventions that are not business methods performed poorly enough across all § 112 requirements to bring down the software group's performance as a whole to a very low level. When other influences on § 112 outcomes were taken into account in our ordered logit models, however, many of the technology-specific differences washed out, with only electronics patents performing better than those in other technology fields on written description and enablement, and mechanical patents doing better on enablement. At the other end of the technology spectrum, software patents other than business methods did very poorly on enablement in the regression model.

Across industry categories, pharmaceutical industry patents perform very well on our descriptive measures if they are of the type that end up in ANDA-related litigation, but are very weak in litigation not triggered by ANDA filings. Those involved in ANDA-induced infringement lawsuits generally covered compositions marketed as brand-name drugs, while those pharmaceutical industry patents involved in litigation triggered by allegedly infringing activities other than ANDA filings were less likely to cover such drugs. Along with pharmaceutical patents not involved in ANDA litigation, those in computer and other electronics industry patents did not fare well in general relative to those in other industries, as most patent observers would have surmised. When other possible influences on § 112 outcomes are included, the regression results reveal that the ANDA-related pharmaceutical patents that performed so well in our descriptive results do not differ in any significant way from those in other industries, although non-ANDA pharmaceutical patents still do very poorly on both written description and definiteness. Patents in the semiconductor industry and in consumer goods and services are significantly more likely than others to withstand challenges on written description grounds. Aside from those mentioned, patents across industry groups do not differ significantly in their performance in the face of § 112 assaults.

Regression results for factors other than technology and industry categories tell some interesting stories. In particular, patents across all technology and fields and industry categories were much more likely to fall on indefiniteness grounds when the challenged claim element was drafted in means-plus-function format, and district courts as a group were significantly more likely than the Federal Circuit to uphold the validity of patents on enablement and definiteness grounds in both our technology and industry models.

Thus, technology and industry do matter when patents are challenged on disclosure and definiteness grounds, but only in a few out of many possible instances. Those few occasions in which we discovered differences sometimes worked out as observers might expect and sometimes they did not. The story thus is a decidedly mixed one.

IV. Caveats and Implications

The results presented in Part III provide a detailed picture of how courts have adjudicated patent disclosure and definiteness across technologies and industries. But one must be cautious about extrapolating from these results to broader claims about non-litigated patents or about the substantive legal standards. For example, based on our findings that the more technical software patents—those not covering business methods—are less likely to survive enablement challenges, one

might be tempted to conclude that either (1) these kinds of software patents, on average, are less well enabled than other patents, or (2) courts have applied a more stringent enablement standard to software patents (or some combination of the two). But neither conclusion is necessarily correct. Not all patents are litigated; not all litigated patents have their validity challenged under § 112; and not all § 112 challenges result in a decision reported on Westlaw.

Rather, most patent lawsuits settle. One of us has reported that of all patent lawsuits filed in 2008 or 2009, less than 10% resulted in a merits decision.[99] Differences in litigation outcomes (i.e., in cases that do not settle) thus might stem from differences in the structure of litigation in different industries rather than differences in the substantive legal standards or in the underlying patents—a problem known as the selection effect. As George Priest and Benjamin Klein famously explained in 1984, where the parties to a litigation have equal stakes, rational expectations, and accurate information about expected outcomes, all but the most uncertain cases will settle, and plaintiff win rates will tend toward 50 percent regardless of the substantive legal standard.[100] As these assumptions are relaxed, the win rate will vary; for example, Priest and Klein explain that when plaintiffs have more at stake than defendants, plaintiffs are likely to win more than 50 percent of cases—again, independent of the substantive legal standard.[101] An extensive literature has documented the ways in which actual litigation deviates from the Priest-Klein assumptions,[102] including in the patent context.[103]

Thus, some of our observed deviations in outcome by technology or industry may be caused by technology-specific differences in which patents are litigated under § 112, or which litigations are likely to settle before any published decision. As one of us has explained for a companion project, there are numerous plausible technology-specific selection stories.[104] For example, pharmaceutical patent holders may have stronger incentives than other patent owners to settle their cases.[105] On the other hand, because each individual pharmaceutical patent is typically

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[99] Allison et al., *Realities of Modern Patent Litigation*, *supra* note 5, at 1780.

[100] George L. Priest & Benjamin Klein, *The Selection of Disputes for Litigation*, 13 J. LEGAL STUD. 1 (1984).

[101] *Id.* at 26.

[102] *See, e.g.*, Daniel Kessler, Thomas Meites & Geoffrey Miller, *Explaining Deviations from the Fifty-Percent Rule: A Multimodal Approach to the Selection of Cases for Litigation*, 25 J. LEGAL STUD. 233, 233 (1996) ("Based on data from 3,529 cases, we find that 'multimodal' case characteristics associated with violations of these assumptions cause plaintiff win rates to deviate from the 50-percent baseline in the manner that simple law-and-economics models would suggest."); Steven Shavell, *Any Frequency of Plaintiff Victory at Trial Is Possible*, 25 J. LEGAL STUD. 493, 495 (1996) ("Although there are no errors of logic in the Priest-Klein model . . . the assumptions of the model that lead to the 50 percent tendency appear to be special . . . .").

[103] *See, e.g.*, Kimberly A. Moore, *Judges, Juries, and Patent Cases—An Empirical Peek Inside the Black Box*, 99 MICH. L. REV. 365, 377 (2000) ("At least one of [the Priest-Klein] assumptions does not hold true in patent cases. . . . In most competitive markets, the patent holder has a much greater stake in the outcome of the litigation than does the alleged infringer.").

[104] Allison et al., *Divided Patent System*, *supra* note 5, manuscript at 56-61.

[105] *See* C. Scott Hemphill & Mark A. Lemley, *Earning Exclusivity: Generic Drug Incentives and the Hatch-Waxman Act*, 77 ANTITRUST L.J. 947 (2011) (discussing the strong incentives of brand-name pharmaceutical companies to settle patent lawsuits).

more valuable than the average patent in other industries,[106] patent owners may be more willing to undertake the high costs of patent litigation in the pharmaceutical industry. Non-practicing entities (NPEs), which are particularly prevalent in the software and computer industries, may be more willing to assert weaker patents and more interested in settling lawsuits.[107] In sum, it is easy to generate plausible causal narratives,[108] but hard to determine which directions these effects will cut in practice.

If deviations from the 50-percent win rate were only due to violations of the Priest-Klein assumptions, then win-rate data would only illustrate these structural factors (such as differential stakes or information asymmetries), rather than substantive differences between cases. However, there are at least three reasons to think that our outcome results might be more illuminating. First, as Kevin Clermont has explained, case strength may survive the selection process "because of imperfect case selection," such that "win rates may retain residual meaning, which the settlement process has not obliterated."[109] Indeed, Daniel Klerman and Yoon-Ho Alex Lee recently demonstrated that "under the three standard settlement models and a wide array of parameters and distribution functions, the proportion of plaintiff victories at trial will vary in a predictable fashion with the legal standard, legal decision makers, or case characteristics."[110] Second, as Jason Rantanen has pointed out, the Priest-Klein hypothesis applies only to overall *disputes*, not to the selection of individual *issues* such as § 112 validity.[111] Patent cases typically involve many issues, and if parties do not agree to drop issues that are not close calls, then outcomes on those issues might be more meaningful. Third, our nuanced coding of decisions in which there are fact issues remaining (such as denials of summary judgment) captures a somewhat richer picture of § 112 adjudication than studies that have focused only on merits rulings.[112] While there are still many cases that will be resolved before the court has any opportunity to opine on § 112 issues, our data at least includes some cases that are later settled.[113]

From a methodological standpoint, we believe that there is substantial value in empirically and doctrinally examining what courts do in patent law, both on specific issues and on broader

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[106] *See* Ouellette, *supra* note 97, at 300-03 (reviewing the literature on the perceived high value of patents in the pharmaceutical industry, and providing data on the low number of patents per pharmaceutical product).

[107] *See* John R. Allison, Mark A. Lemley & Joshua Walker, *Patent Quality and Settlement Among Repeat Patent Litigants*, 99 GEO. L.J. 677 (2011) (finding that repeat patent plaintiffs, which are dominated by software-patent-owning NPEs, are more likely to settle their cases and more likely to lose when they go to final judgment).

[108] *See generally* DANIEL KAHNEMAN, THINKING, FAST AND SLOW 199-202 (2011).

[109] Kevin M. Clermont, *Litigation Realities Redux*, 84 NOTRE DAME L. REV. 1919, 1966 (2009).

[110] Daniel Klerman & Yoon-Ho Alex Lee, *Inferences from Litigated Cases*, 43 J. LEGAL STUD. 209, 238 (2014).

[111] Jason Rantanen, *Why Priest-Klein Cannot Apply to Individual Issues in Patent Cases* (Univ. Iowa Legal Studies Research Paper No. 12-15, 2012), *available at* http://ssrn.com/abstract=2132810.

[112] Allison et al., *Realities of Modern Patent Litigation*, *supra* note 5, at 1790 ("[M]any cases are settled after a denial of summary judgment and before trial. These patents are not included in our statistics on definitive rulings, and many presumably involve a monetary payment to the patentee.").

[113] Also note that by focusing only on granted patents, we avoid the ambiguity of differing decision standards for patent applications that are not subject to the presumption of validity. *See* Ouellette, *supra* note 52, at 368 (discussing the application of Priest-Klein in the differing contexts of granted patents and applications).

policy questions and trends. When researchers subject specific patent law issues to empirical analysis as we have done, it is important to simultaneously keep the broader view in mind. Our finding on patent disclosure and claim definiteness holdings over a thirty-year period do not, for instance, say anything about overall patent quality or economic value. They also have little if anything to say about overall patent litigation outcomes, particularly about how the difficulty of actually winning a patent infringement case affects the value of patents to their owners. Allison, Lemley, and Schwarz recently found that patentees could claim an overall victory in patent litigation on both infringement and validity of only 26%, a rate consistent with that found previously by others.[114]

The fundamental reason for the difficulty faced by patent owners in infringement litigation, as Mark Lemley has observed, is that they must overcome many distinct hurdles to win and only have to fail on one of them to lose the case. The patentee must not only prove infringement, but also must fend off any number of invalidity challenges. To fail on any one means to lose the case, and to lose on a single invalidity assertion means to lose the patent itself.[115] Although no single patent will ever be vulnerable to more than a small fraction of the total number of possible validity challenges, the phenomenon of conditional probabilities means that it takes only a few hurdles for a patent owner's chances of prevailing in litigation to plummet. If, for example, a litigated patent is confronted by invalidity challenges on three separate grounds, a not unrealistic number, and if the likelihood of the patent owner's success on each issue is 80% (giving the challenger a hypothetical 20% chance of proving invalidity by clear and convincing evidence on each issue), the patent owner stands only a 41% chance of winning on all of these validity issues, which translates to a 59% chance of losing its patent for good. A patent owner must also prove infringement to win a case, of course, and if it has, say, a 50/50 chance of doing so, it has only a 20.5% chance of prevailing overall.

Conclusion

There is a bit of truth in the conventional wisdom that judicial application of patent disclosure and claim definiteness requirements varies among technologies and industries, although after influences other than technology and industry are factored in, the nature of such variability is not always as may have been supposed, and its degree not as striking as many observers may have guessed. Our findings are, of course, limited not only by the selection effects discussed above, but possibly by other factors that are either undiscoverable or unmeasurable.

We also discovered several very interesting effects on outcomes other than technology and industry class. These include the fact that district courts as a group were significantly more likely than the Federal Circuit to uphold patents against charges that they lacked an enabling specification or contained an indefinite claim, the large negative effect that drafting a claim element in means-plus-function format had on the patent claim's ability to withstand a challenge on indefiniteness grounds, and the highly significant positive impact that a decision's post-*Markman* date had on the

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[114] Allison et al., *Realities of Modern Patent Litigation, supra* note 5, at 1787.

[115] Mark A. Lemley, *The Fractioning of Patent Law*, *in* INTELLECTUAL PROPERTY AND THE COMMON LAW 504 (Shyamkrishna Balganesh ed., 2013).

ability of a patent to survive an indefiniteness challenge.

Appendix

Table A1. Enablement Outcomes by Technology (Primary + Secondary)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	3-level	3-level	5-level	5-level	3-level	3-level	5-level	5-level
mechanical	0.442	0.424	0.340	0.333	0.490	0.479	0.365	0.368
	(0.202)	(0.237)	(0.262)	(0.300)	(0.165)	(0.196)	(0.242)	(0.283)
electrical	0.0765	0.112	-0.101	-0.103	0.132	0.183	-0.0709	-0.0559
	(0.789)	(0.712)	(0.706)	(0.732)	(0.659)	(0.568)	(0.799)	(0.866)
chemical	0.0324	0.0575	-0.111	-0.126	0.0785	0.118	-0.0869	-0.0850
	(0.932)	(0.886)	(0.731)	(0.711)	(0.841)	(0.773)	(0.800)	(0.821)
biotech	-0.112	0.111	-0.330	-0.182	-0.0626	0.173	-0.305	-0.141
	(0.809)	(0.820)	(0.401)	(0.646)	(0.892)	(0.730)	(0.444)	(0.744)
software	-1.044***	-1.035***	-0.902***	-0.915***				
	(0.00113)	(0.00172)	(0.00401)	(0.00814)				
software: bus. meths.					-0.504	-0.392	-0.378	-0.246
					(0.360)	(0.596)	(0.561)	(0.721)
software: not bus. meths.					-1.121***	-1.116***	-0.979***	-1.002***
					(0.000555)	(0.00115)	(0.00231)	(0.00533)
reissue patent		-0.211		-0.265		-0.251		-0.309
		(0.806)		(0.550)		(0.768)		(0.511)
declaratory judgment		-0.0527		0.0731		-0.00931		0.110
		(0.875)		(0.790)		(0.978)		(0.686)
district court decision		0.653**		0.672***		0.640**		0.662***
		(0.0144)		(0.00327)		(0.0163)		(0.00353)
foreign origin		1.063		0.988		1.120		1.041
		(0.554)		(0.179)		(0.370)		(0.151)
foreign priority		-0.379		-0.412		-0.397		-0.441
		(0.836)		(0.614)		(0.755)		(0.583)
post-*Markman*		-0.602*		-0.275		-0.611*		-0.286
		(0.0966)		(0.274)		(0.0991)		(0.248)
E.D. Tex.		-0.195		-0.562		-0.371		-0.688
		(0.858)		(0.312)		(0.767)		(0.219)
N.D. Cal.		-0.470*		-0.348		-0.449*		-0.328
		(0.0812)		(0.205)		(0.0932)		(0.233)
D. Del.		-0.171		-0.120		-0.218		-0.160
		(0.540)		(0.653)		(0.443)		(0.555)
observations	433	433	433	433	433	433	433	433

Values in parentheses are p-values, with *** p<0.01, ** p<0.05, * p<0.1. All regressions use the ordered logit estimator. The unspecified comparison technology variable is optics.

Table A2. Written Description Outcomes by Technology (Primary + Secondary)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	3-level	3-level	5-level	5-level	3-level	3-level	5-level	5-level
mechanical	0.217	0.228	0.206	0.251	0.151	0.144	0.148	0.176
	(0.589)	(0.579)	(0.507)	(0.491)	(0.700)	(0.752)	(0.649)	(0.649)
electrical	1.456***	1.520***	1.097***	1.300***	1.370***	1.412***	1.037***	1.221***
	(0.000330)	(0.000752)	(0.000144)	(9.88e-05)	(0.000944)	(0.00144)	(0.000244)	(0.000726)
chemical	0.378	0.283	0.265	0.175	0.316	0.186	0.210	0.0934
	(0.446)	(0.585)	(0.488)	(0.686)	(0.529)	(0.743)	(0.587)	(0.836)
biotech	-0.0800	0.108	-0.0382	0.117	-0.149	0.0140	-0.0981	0.0386
	(0.880)	(0.840)	(0.934)	(0.804)	(0.772)	(0.981)	(0.832)	(0.939)
software	-0.509	-0.370	-0.454	-0.374				
	(0.180)	(0.369)	(0.166)	(0.301)				
software: bus. meths.					-1.048*	-0.972	-0.926*	-0.842
					(0.0505)	(0.126)	(0.0683)	(0.161)
software: not bus. meths.					-0.348	-0.218	-0.322	-0.269
					(0.349)	(0.612)	(0.298)	(0.449)
reissue patent		0.791		0.900		0.799		0.908
		(0.822)		(0.242)		(0.785)		(0.296)
declaratory judgment		0.378		0.363		0.319		0.318
		(0.401)		(0.358)		(0.481)		(0.445)
district court decision		-0.00752		0.119		-0.0371		0.101
		(0.979)		(0.623)		(0.896)		(0.684)
foreign origin		0.381		0.0723		0.328		0.0489
		(0.591)		(0.862)		(0.555)		(0.909)
foreign priority		0.230		0.482		0.229		0.467
		(0.760)		(0.311)		(0.700)		(0.349)
post-*Markman*		-0.549		0.111		-0.532		0.134
		(0.471)		(0.718)		(0.466)		(0.661)
E.D. Tex.		0.0746		-0.489		0.239		-0.394
		(0.941)		(0.418)		(0.821)		(0.541)
N.D. Cal.		-0.0308		-0.166		-0.0731		-0.208
		(0.934)		(0.651)		(0.844)		(0.557)
D. Del.		0.442		0.337		0.525		0.376
		(0.218)		(0.240)		(0.170)		(0.197)
observations	299	299	299	299	299	299	299	299

Values in parentheses are p-values, with *** p<0.01, ** p<0.05, * p<0.1. All regressions use the ordered logit estimator. The unspecified comparison technology variable is optics.

Table A3. Indefiniteness Outcomes by Technology (Primary + Secondary)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	3-level	3-level	5-level	5-level	3-level	3-level	5-level	5-level
mechanical	0.233	0.185	0.347	0.294	0.168	0.120	0.304	0.259
	(0.518)	(0.677)	(0.270)	(0.452)	(0.626)	(0.777)	(0.332)	(0.488)
electrical	-0.151	-0.133	-0.0535	0.00597	-0.243	-0.229	-0.113	-0.0525
	(0.593)	(0.688)	(0.842)	(0.984)	(0.396)	(0.522)	(0.676)	(0.866)
chemical	-0.225	-0.339	0.0532	0.00375	-0.293	-0.407	0.00833	-0.0337
	(0.575)	(0.486)	(0.877)	(0.993)	(0.446)	(0.377)	(0.981)	(0.934)
biotech	0.193	0.339	0.382	0.427	0.122	0.261	0.336	0.382
	(0.863)	(0.716)	(0.487)	(0.450)	(0.918)	(0.851)	(0.528)	(0.609)
software	-0.515	-0.165	0.00272	0.242				
	(0.145)	(0.708)	(0.993)	(0.512)				
software: bus. meths.					-0.991**	-0.694	-0.365	-0.138
					(0.0233)	(0.174)	(0.397)	(0.783)
software: not bus. meths.					-0.430	-0.0505	0.0701	0.326
					(0.203)	(0.909)	(0.816)	(0.394)
MPF claim element		-1.570***		-1.673***		-1.550***		-1.659***
		(4.01e-08)		(2.32e-09)		(1.21e-08)		(1.17e-08)
reissue patent		0.758		0.361		0.774		0.376
		(0.862)		(0.759)		(0.871)		(0.764)
declaratory judgment		-0.187		-0.261		-0.219		-0.275
		(0.556)		(0.339)		(0.510)		(0.332)
district court decision		0.529**		0.476**		0.525**		0.475**
		(0.0259)		(0.0231)		(0.0330)		(0.0263)
foreign origin		1.125		1.429		1.170		1.460
		(0.544)		(0.489)		(0.535)		(0.510)
foreign priority		-1.459		-1.800		-1.579		-1.872
		(0.435)		(0.386)		(0.407)		(0.398)
post-*Markman*		0.212		0.645***		0.233		0.660***
		(0.559)		(0.00756)		(0.509)		(0.00538)
E.D. Tex.		-0.269		-0.105		-0.339		-0.147
		(0.399)		(0.756)		(0.298)		(0.674)
N.D. Cal.		0.321		0.386		0.351		0.411
		(0.390)		(0.215)		(0.336)		(0.222)
D. Del.		0.163		-0.199		0.219		-0.175
		(0.612)		(0.416)		(0.460)		(0.473)
observations	673	673	673	673	673	673	673	673

Values in parentheses are p-values, with *** p<0.01, ** p<0.05, * p<0.1. All regressions use the ordered logit estimator. The unspecified comparison technology variable is optics.

Table A4. Enablement Outcomes by Technology (Primary Only)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	3-level	3-level	5-level	5-level	3-level	3-level	5-level	5-level
mechanical	0.994**	1.007**	1.070**	1.095**	0.996**	1.008**	1.072**	1.099**
	(0.0206)	(0.0357)	(0.0176)	(0.0160)	(0.0257)	(0.0273)	(0.0145)	(0.0226)
electrical	0.750	0.874*	0.773	0.859*	0.751	0.877*	0.774	0.864*
	(0.135)	(0.0938)	(0.126)	(0.0796)	(0.128)	(0.0791)	(0.116)	(0.0938)
chemical	0.520	0.574	0.579	0.602	0.521	0.585	0.581	0.616
	(0.244)	(0.224)	(0.225)	(0.188)	(0.252)	(0.200)	(0.216)	(0.197)
biotech	0.389	0.653	0.352	0.548	0.390	0.657	0.353	0.556
	(0.457)	(0.240)	(0.491)	(0.272)	(0.475)	(0.216)	(0.483)	(0.287)
software	-0.614	-0.528	-0.335	-0.297				
	(0.165)	(0.269)	(0.487)	(0.534)				
software: bus. meths.					-0.0321	0.123	0.297	0.475
					(0.955)	(0.844)	(0.661)	(0.535)
software: not bus. meths.					-0.765	-0.681	-0.469	-0.450
					(0.117)	(0.148)	(0.328)	(0.384)
reissue patent		-0.127		-0.208		-0.166		-0.260
		(0.878)		(0.634)		(0.813)		(0.586)
declaratory judgment		-0.0524		0.0884		-0.00197		0.137
		(0.877)		(0.744)		(0.996)		(0.605)
district court decision		0.615**		0.658***		0.599**		0.647***
		(0.0208)		(0.00535)		(0.0256)		(0.00439)
foreign origin		1.073		0.923		1.145		1.000
		(0.491)		(0.182)		(0.461)		(0.175)
foreign priority		-0.364		-0.312		-0.403		-0.367
		(0.819)		(0.685)		(0.801)		(0.648)
post-*Markman*		-0.561		-0.266		-0.567		-0.278
		(0.143)		(0.271)		(0.115)		(0.290)
E.D. Tex.		-0.170		-0.541		-0.353		-0.679
		(0.908)		(0.516)		(0.748)		(0.227)
N.D. Cal.		-0.481*		-0.378		-0.445		-0.344
		(0.0738)		(0.187)		(0.108)		(0.222)
D. Del.		-0.176		-0.144		-0.223		-0.189
		(0.529)		(0.589)		(0.412)		(0.487)
observations	433	433	433	433	433	433	433	433

Values in parentheses are p-values, with *** p<0.01, ** p<0.05, * p<0.1. All regressions use the ordered logit estimator. The unspecified comparison technology variable is optics.

Table A5. Written Description Outcomes by Technology (Primary Only)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	3-level	3-level	5-level	5-level	3-level	3-level	5-level	5-level
mechanical	0.561	0.465	0.405	0.371	0.563	0.453	0.409	0.370
	(0.467)	(0.663)	(0.393)	(0.513)	(0.512)	(0.699)	(0.374)	(0.504)
electrical	1.325	1.293	1.080**	1.205**	1.330	1.290	1.088**	1.217**
	(0.110)	(0.258)	(0.0475)	(0.0385)	(0.204)	(0.296)	(0.0362)	(0.0373)
chemical	0.583	0.385	0.375	0.231	0.586	0.348	0.380	0.212
	(0.463)	(0.727)	(0.446)	(0.693)	(0.503)	(0.773)	(0.431)	(0.711)
biotech	0.126	0.223	0.0776	0.183	0.127	0.207	0.0792	0.182
	(0.877)	(0.841)	(0.888)	(0.765)	(0.888)	(0.864)	(0.883)	(0.766)
software	-0.167	-0.127	-0.231	-0.192				
	(0.827)	(0.906)	(0.643)	(0.736)				
software: bus. meths.					-0.744	-0.802	-0.712	-0.727
					(0.416)	(0.515)	(0.202)	(0.269)
software: not bus. meths.					0.120	0.175	0.0103	0.0677
					(0.891)	(0.883)	(0.984)	(0.910)
reissue patent		0.758		0.898		0.800		0.926
		(0.806)		(0.249)		(0.796)		(0.130)
declaratory judgment		0.264		0.255		0.193		0.196
		(0.568)		(0.537)		(0.664)		(0.624)
district court decision		-0.00692		0.0948		-0.0451		0.0711
		(0.981)		(0.706)		(0.880)		(0.772)
foreign origin		0.564		0.341		0.477		0.281
		(0.448)		(0.397)		(0.518)		(0.497)
foreign priority		0.00163		0.151		0.0375		0.176
		(0.998)		(0.748)		(0.962)		(0.718)
post-*Markman*		-0.546		0.148		-0.525		0.176
		(0.303)		(0.634)		(0.463)		(0.575)
E.D. Tex.		0.281		-0.201		0.477		-0.0847
		(0.860)		(0.721)		(0.787)		(0.888)
N.D. Cal.		-0.0408		-0.213		-0.105		-0.281
		(0.915)		(0.550)		(0.768)		(0.429)
D. Del.		0.411		0.256		0.510		0.309
		(0.261)		(0.370)		(0.172)		(0.279)
observations	299	299	299	299	299	299	299	299

Values in parentheses are p-values, with *** p<0.01, ** p<0.05, * p<0.1. All regressions use the ordered logit estimator. The unspecified comparison technology variable is optics.

Table A6. Indefiniteness Outcomes by Technology (Primary Only)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	3-level	3-level	5-level	5-level	3-level	3-level	5-level	5-level
mechanical	0.232	0.122	0.131	0.0372	0.232	0.126	0.131	0.0406
	(0.944)	(0.970)	(0.905)	(0.979)	(0.938)	(0.973)	(0.897)	(0.974)
electrical	-0.163	-0.0937	-0.279	-0.179	-0.163	-0.0923	-0.280	-0.180
	(0.961)	(0.977)	(0.803)	(0.900)	(0.957)	(0.981)	(0.788)	(0.886)
chemical	-0.252	-0.394	-0.230	-0.285	-0.252	-0.394	-0.230	-0.284
	(0.939)	(0.902)	(0.834)	(0.838)	(0.933)	(0.917)	(0.820)	(0.818)
biotech	0.152	0.270	0.0986	0.128	0.152	0.266	0.0986	0.125
	(0.965)	(0.937)	(0.933)	(0.933)	(0.964)	(0.946)	(0.929)	(0.923)
software	-0.621	-0.324	-0.337	-0.133				
	(0.851)	(0.919)	(0.760)	(0.925)				
software: bus. meths.					-0.947	-0.705	-0.589	-0.407
					(0.752)	(0.852)	(0.578)	(0.749)
software: not bus. meths.					-0.501	-0.166	-0.251	-0.0290
					(0.867)	(0.965)	(0.806)	(0.981)
MPF claim element		-1.525***		-1.619***		-1.513***		-1.610***
		(1.23e-07)		(7.51e-09)		(2.32e-07)		(1.14e-08)
reissue patent		0.767		0.371		0.775		0.378
		(0.875)		(0.780)		(0.869)		(0.745)
declaratory judgment		-0.197		-0.270		-0.225		-0.283
		(0.551)		(0.321)		(0.497)		(0.279)
district court decision		0.512**		0.486**		0.504**		0.483**
		(0.0307)		(0.0221)		(0.0314)		(0.0278)
foreign origin		1.127		1.409		1.180		1.443
		(0.576)		(0.517)		(0.569)		(0.401)
foreign priority		-1.453		-1.763		-1.570		-1.831
		(0.472)		(0.417)		(0.450)		(0.287)
post-*Markman*		0.228		0.674***		0.247		0.686***
		(0.518)		(0.00440)		(0.486)		(0.00416)
E.D. Tex.		-0.201		-0.0431		-0.267		-0.0820
		(0.544)		(0.901)		(0.424)		(0.811)
N.D. Cal.		0.346		0.378		0.373		0.398
		(0.323)		(0.206)		(0.311)		(0.207)
D. Del.		0.191		-0.188		0.241		-0.168
		(0.549)		(0.435)		(0.434)		(0.485)
observations	673	673	673	673	673	673	673	673

Values in parentheses are p-values, with *** p<0.01, ** p<0.05, * p<0.1. All regressions use the ordered logit estimator. The unspecified comparison technology variable is optics.

Table A7. Enablement Outcomes by Industry

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	3-level	3-level	5-level	5-level	3-level	3-level	5-level	5-level
computer & other electronics	-1.872*** (5.64e-05)	-1.941*** (0.000943)	-1.421*** (2.79e-05)	-1.618*** (0.000289)	-1.874*** (3.32e-05)	-1.948*** (0.00131)	-1.425*** (1.49e-05)	-1.623*** (0.000277)
semiconductor	-0.304 (0.414)	-0.149 (0.698)	-0.332 (0.331)	-0.227 (0.509)	-0.305 (0.404)	-0.142 (0.726)	-0.333 (0.302)	-0.220 (0.518)
pharma	-0.0888 (0.817)	-0.0773 (0.855)	-0.139 (0.694)	-0.118 (0.753)				
pharma: ANDA					0.178 (0.708)	0.205 (0.694)	0.128 (0.749)	0.0905 (0.841)
pharma: non-ANDA					-0.475 (0.366)	-0.474 (0.425)	-0.548 (0.249)	-0.428 (0.397)
biotech	-0.0225 (0.963)	0.196 (0.711)	-0.165 (0.685)	0.0287 (0.944)	-0.0225 (0.963)	0.192 (0.708)	-0.165 (0.679)	0.0277 (0.946)
medical devices & methods	0.0378 (0.889)	0.173 (0.590)	0.000370 (0.999)	0.0137 (0.965)	0.0379 (0.893)	0.181 (0.568)	0.000320 (0.999)	0.0212 (0.946)
communications	0.0425 (0.934)	0.115 (0.830)	0.160 (0.739)	0.119 (0.823)	0.0425 (0.960)	0.122 (0.819)	0.160 (0.735)	0.125 (0.808)
transportation (incl. auto)	-0.530 (0.478)	-0.830 (0.319)	-0.632 (0.358)	-1.050 (0.185)	-0.530 (0.354)	-0.830 (0.228)	-0.633 (0.363)	-1.043 (0.184)
construction	0.459 (0.688)	0.255 (0.880)	0.223 (0.619)	0.0878 (0.861)	0.459 (0.656)	0.252 (0.872)	0.223 (0.619)	0.0853 (0.876)
energy	0.924 (0.655)	1.007 (0.645)	0.480 (0.309)	0.702 (0.170)	0.925 (0.680)	1.006 (0.591)	0.482 (0.313)	0.702 (0.179)
consumer goods & services	0.283 (0.419)	0.259 (0.527)	0.669 (0.117)	0.659 (0.130)	0.283 (0.424)	0.264 (0.512)	0.670* (0.0811)	0.667 (0.133)
reissue patent		-0.130 (0.904)		-0.221 (0.607)		-0.109 (0.885)		-0.192 (0.694)
declaratory judgment		0.403 (0.319)		0.506* (0.0918)		0.426 (0.278)		0.523* (0.0906)
dist. ct. decision		0.540* (0.0568)		0.630** (0.0134)		0.524** (0.0438)		0.614** (0.0134)
foreign origin		1.426 (0.395)		1.352* (0.0558)		1.432 (0.322)		1.343* (0.0610)
foreign priority		-0.735 (0.667)		-0.740 (0.337)		-0.764 (0.607)		-0.747 (0.349)
post-*Markman*		-0.618 (0.104)		-0.304 (0.256)		-0.635* (0.0916)		-0.315 (0.226)
E.D. Tex.		-0.479 (0.745)		-0.654 (0.227)		-0.473 (0.784)		-0.640 (0.245)
N.D. Cal.		-0.472 (0.101)		-0.316 (0.258)		-0.473 (0.110)		-0.316 (0.269)
D. Del.		-0.229 (0.456)		-0.136 (0.643)		-0.239 (0.436)		-0.136 (0.661)
observations	433	433	433	433	433	433	433	433

Values in parentheses are p-values, with *** p<0.01, ** p<0.05, * p<0.1. All regressions use the ordered logit estimator. The unspecified comparison industry is goods & services for industrial and business purposes.

Table A8. Written Description Outcomes by Industry

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	3-level	3-level	5-level	5-level	3-level	3-level	5-level	5-level
computer & other electronics	-0.239 (0.598)	-0.0646 (0.894)	-0.347 (0.384)	-0.215 (0.639)	-0.241 (0.585)	-0.0935 (0.842)	-0.350 (0.418)	-0.236 (0.592)
semiconductor	1.567 (0.579)	1.683 (0.563)	0.989** (0.0228)	1.038** (0.0350)	1.577 (0.596)	1.754 (0.553)	1.000** (0.0192)	1.085** (0.0333)
pharma	-0.546 (0.287)	-0.564 (0.304)	-0.566* (0.0923)	-0.555 (0.137)				
pharma: ANDA					0.734 (0.724)	0.947 (0.626)	0.120 (0.742)	0.155 (0.720)
pharma: non-ANDA					-1.672 (0.211)	-1.914* (0.0841)	-1.254*** (0.000969)	-1.214*** (0.00128)
biotech	-0.322 (0.546)	-0.0633 (0.915)	-0.366 (0.494)	-0.147 (0.806)	-0.325 (0.551)	-0.0568 (0.926)	-0.370 (0.502)	-0.140 (0.824)
medical devices & methods	-0.139 (0.689)	-0.170 (0.703)	-0.262 (0.438)	-0.283 (0.540)	-0.141 (0.675)	-0.155 (0.737)	-0.263 (0.461)	-0.268 (0.538)
communications	-0.0848 (0.917)	-0.423 (0.567)	-0.166 (0.791)	-0.374 (0.662)	-0.0857 (0.903)	-0.433 (0.577)	-0.166 (0.800)	-0.371 (0.664)
transportation (incl. auto)	-0.129 (0.779)	0.206 (0.707)	0.0814 (0.907)	0.293 (0.701)	-0.130 (0.780)	0.200 (0.715)	0.0801 (0.905)	0.298 (0.743)
construction	0.811 (0.783)	1.063 (0.738)	0.450 (0.548)	0.592 (0.497)	0.817 (0.805)	1.072 (0.712)	0.457 (0.455)	0.593 (0.480)
energy	0.292 (0.829)	0.00164 (0.999)	-0.0665 (0.899)	-0.304 (0.589)	0.295 (0.833)	-0.0420 (0.976)	-0.0639 (0.905)	-0.327 (0.558)
consumer goods & services	0.778* (0.0814)	1.075** (0.0374)	0.850* (0.0565)	0.967* (0.0520)	0.785* (0.0840)	1.105** (0.0328)	0.858* (0.0609)	0.987** (0.0477)
reissue patent		0.190 (0.955)		0.349 (0.606)		0.136 (0.965)		0.340 (0.615)
declaratory judgment		0.363 (0.414)		0.284 (0.506)		0.488 (0.316)		0.344 (0.423)
dist. ct. decision		-0.112 (0.705)		0.0152 (0.952)		-0.163 (0.588)		-0.0269 (0.919)
foreign origin		0.625 (0.301)		0.362 (0.426)		0.774 (0.355)		0.414 (0.344)
foreign priority		0.0835 (0.898)		0.286 (0.558)		-0.222 (0.803)		0.152 (0.769)
post-*Markman*		-1.159 (0.165)		-0.463 (0.130)		-1.432 (0.169)		-0.547* (0.0647)
E.D. Tex.		0.583 (0.688)		0.182 (0.803)		0.674 (0.584)		0.210 (0.775)
N.D. Cal.		0.0902 (0.833)		-0.0201 (0.960)		0.0882 (0.833)		-0.0288 (0.944)
D. Del.		0.753* (0.0800)		0.480 (0.143)		0.685 (0.108)		0.432 (0.178)
observations	299	299	299	299	299	299	299	299

Values in parentheses are p-values, with *** p<0.01, ** p<0.05, * p<0.1. All regressions use the ordered logit estimator. The unspecified comparison industry is goods & services for industrial and business purposes.

Table A9. Indefiniteness Outcomes by Industry

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	3-level	3-level	5-level	5-level	3-level	3-level	5-level	5-level
computer &	0.0691	0.0892	0.362	0.249	0.0691	0.105	0.363	0.265
other electronics	(0.814)	(0.798)	(0.231)	(0.483)	(0.817)	(0.758)	(0.225)	(0.428)
semiconductor	0.462	0.827	-0.266	0.0460	0.462	0.837	-0.266	0.0589
	(0.781)	(0.666)	(0.448)	(0.916)	(0.850)	(0.720)	(0.453)	(0.883)
pharma	-0.0670	-0.306	-0.0187	-0.168				
	(0.838)	(0.368)	(0.948)	(0.609)				
pharma: ANDA					1.127	0.862	0.969	0.722
					(0.714)	(0.792)	(0.533)	(0.537)
pharma:					-0.665*	-0.920**	-0.594*	-0.682**
non-ANDA					(0.0643)	(0.0208)	(0.0670)	(0.0466)
biotech	15.28***	13.31***	1.440	1.180	13.62***	13.33***	1.442	1.194
	(0)	(0)	(0.757)	(0.793)	(0)	(0)	(0.739)	(0.793)
medical devices	0.182	0.0388	0.0625	-0.0589	0.182	0.0493	0.0627	-0.0512
& methods	(0.590)	(0.913)	(0.820)	(0.849)	(0.586)	(0.891)	(0.814)	(0.868)
communications	-0.185	0.128	-0.148	0.109	-0.185	0.133	-0.148	0.111
	(0.588)	(0.743)	(0.642)	(0.755)	(0.592)	(0.734)	(0.637)	(0.741)
transportation	0.647	0.425	0.865	0.648	0.647	0.443	0.867*	0.667
(incl. auto)	(0.462)	(0.620)	(0.106)	(0.356)	(0.609)	(0.727)	(0.0834)	(0.204)
construction	0.473	0.307	0.339	0.265	0.473	0.307	0.339	0.269
	(0.777)	(0.861)	(0.450)	(0.610)	(0.666)	(0.826)	(0.471)	(0.753)
energy	0.806	0.426	0.689	0.262	0.806	0.413	0.690	0.249
	(0.499)	(0.744)	(0.142)	(0.609)	(0.521)	(0.768)	(0.150)	(0.713)
consumer goods	0.235	0.0881	0.325	0.158	0.235	0.105	0.326	0.175
& services	(0.453)	(0.802)	(0.275)	(0.627)	(0.488)	(0.760)	(0.271)	(0.561)
MPF claim		-1.620***		-1.612***		-1.619***		-1.611***
element		(9.42e-10)		(1.76e-08)		(4.64e-09)		(6.46e-09)
reissue patent		0.842		0.383		0.816		0.364
		(0.871)		(0.797)		(0.869)		(0.670)
declaratory		-0.0814		-0.202		-0.0791		-0.200
judgment		(0.794)		(0.458)		(0.798)		(0.438)
dist. ct. decision		0.528**		0.461**		0.513**		0.453**
		(0.0331)		(0.0390)		(0.0347)		(0.0389)
foreign origin		1.178		1.436		1.230		1.487
		(0.566)		(0.483)		(0.533)		(0.411)
foreign priority		-1.466		-1.762		-1.464		-1.778
		(0.477)		(0.393)		(0.458)		(0.326)
post-*Markman*		0.182		0.608***		0.0798		0.541**
		(0.614)		(0.00890)		(0.828)		(0.0199)
E.D. Tex.		-0.292		-0.0708		-0.272		-0.0510
		(0.386)		(0.828)		(0.408)		(0.876)
N.D. Cal.		0.281		0.395		0.241		0.374
		(0.418)		(0.219)		(0.515)		(0.230)
D. Del.		0.150		-0.193		0.239		-0.114
		(0.631)		(0.436)		(0.430)		(0.655)
observations	673	673	673	673	673	673	673	673

Values in parentheses are p-values, with *** p<0.01, ** p<0.05, * p<0.1. All regressions use the ordered logit estimator. The unspecified comparison industry is goods & services for industrial and business purposes.