Duke Law Journal

VOLUME 65 JANUARY 2016 NUMBER 4

HOW COURTS ADJUDICATE PATENT DEFINITENESS AND DISCLOSURE

JOHN R. ALLISON† & LISA LARRIMORE OUELLETTE††

ABSTRACT

Section 112 of the Patent Act requires patentees to clearly explain what their invention is (a requirement known as claim definiteness), as well as how to make and use it (the disclosure requirements of enablement and written description). Many concerns about the modern patent system stem from these requirements. But despite the critical importance of § 112 to the functioning of the patent system, there is surprisingly little empirical data about how it has been applied in practice. To remedy the reliance on anecdotes, we have created a hand-coded dataset of 1144 reported court decisions from 1982 to 2012 in which U.S. district courts or the Court of Appeals for the Federal Circuit rendered a decision on the enablement, written-description, or claim-definiteness requirements of § 112. We coded validity outcomes under these three doctrines on a novel five-level scale so as to capture significant subtlety in the strength of each decision, and we also classified patents by technology and industry categories. We also coded for a number of litigation characteristics

Copyright © 2016 John R. Allison & Lisa Larrimore Ouellette.

† Mary John and Ralph Spence Centennial Professor of Business, McCombs Graduate School of Business, University of Texas at Austin.

†† Assistant Professor of Law, Stanford Law School. For helpful comments, we thank Michael Frakes, Scott Hemphill, Jeff Larrimore, Mark Lemley, Nick Ouellette, Jason Rantanen, Michael Risch, David Schwartz, Ted Sichelman, Kathy Strandburg, and participants at the 2015 American Law and Economics Association Meeting, PatCon V, the Northwestern Searle Center Roundtable on Innovation Economics, and the January 2015 Hoover IP^2 conference. We also thank Yingda Zhai for outstanding assistance with the statistical analyses, Julie Patel for help with initial data collection, Neha Ready for help with data cleaning, Rachael Samberg and Matthaeus Weinhardt for research assistance, and the Hoover Institution for supporting this work. The dataset and the Stata files for creating the regressions presented here are available in the Duke Law Scholarship Repository at http://scholarship.law.duke.edu/dlj/.

that could arguably influence outcomes. Although one must be cautious about generalizing from reported decisions due to selection effects, our results show some statistically significant disparities in § 112 outcomes for different technologies and industries—although fewer than the conventional wisdom suggests, and not always in the direction that many have believed. Just as importantly, our analysis reveals significant relationships between other variables and § 112 litigation outcomes, 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*. Our results showing how § 112 has been applied in practice will be helpful in evaluating current proposals for reform, and our rich dataset will enable more systematic studies of these critical doctrines in the future.*

TABLE OF CONTENTS

INTRODUCTION

In exchange for the rights provided by a patent, section 112 of the Patent Act requires patentees to clearly explain what their invention is (a requirement known as claim definiteness), as well as how to make and use it (the disclosure requirements of enablement and written description).[1] These requirements are at the root of many concerns about the modern patent system. Patents cannot serve as efficient property rights if no one can determine their boundaries, and disclosure failures can lead to patents that cover far more than was actually invented. Better enforcement of § 112 thus may be the best way to address the problem of "patent trolls" asserting overbroad and unclear patents.[2] Commentators also have frequently opined that despite patent law's nominal uniformity across different technologies or industries,[3] disclosure and definiteness are applied dissimilarly by courts to different technologies and industries.[4] But despite the critical importance of § 112 to the functioning of the patent system, there is surprisingly little empirical data about how it has been applied in practice. In this Article, we seek to remedy this empirical dearth.

Understanding the state of § 112 litigation is particularly important in light of the growing conflict over the application of these patentability requirements. Commentators have argued, for example, that the written-description doctrine should be eliminated,[5] and that the enablement and definiteness requirements should be enforced

1. *See* 35 U.S.C. § 112(a)–(b) (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"); *infra* notes 19–32 and accompanying text.

2. *See, e.g.*, Brief Amicus Curiae of Professor Peter S. Menell in Support of Neither Party at 3–4, Nautilus, Inc. v. Biosig Instruments, Inc., 134 S. Ct. 2120 (2014) (No. 13-369); Mark A. Lemley, *Software Patents and the Return of Functional Claiming*, 2013 WIS. L. REV. 905, 905–06.

3. *See* Clarisa Long, *Our Uniform Patent System*, 55 FED. LAW. 44, 48 (2008).

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

5. *See* Ariad Pharm., Inc. v. Eli Lilly & Co., 598 F.3d 1336, 1361–67 (Fed. Cir. 2010) (en banc) (Rader, J., dissenting in part) (criticizing the en banc majority's holding that § 112 contains a written-description requirement that is separate from the enablement requirement); 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, 964–66 (2012) (arguing that the Supreme Court should intervene to fix problems with the written-description requirement).

much more stringently.[6] The Supreme Court set forth a new test for indefiniteness in 2014, the contours of which remain uncertain.[7] Our results on how § 112 has been applied in practice will be helpful in evaluating current proposals for reform, and our rich dataset—which we are making publicly available—will enable more systematic studies of these critical doctrines in the future.[8]

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 reported decision—including denials of summary judgment—involving any of three § 112 issues: enablement, written description, or claim definiteness. We explain these three doctrines in more detail in Part I. In short, definiteness requires that other skilled individuals in the particular field 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. Our dataset contains 1144 decisions on at least one of these issues. We hand coded the outcomes of these cases using a five-level ordinal scale, allowing us to capture subtleties in the strength of each decision. We compare these results to coarser validity outcomes. We placed each patent in one of six technology categories (plus a secondary technology area when warranted) and in one of eleven industry categories.[9] We also

6. *See, e.g.*, Brief Amicus Curiae of Professor Peter S. Menell in Support of Neither Party, *supra* note 2, at 36–42; Lisa Larrimore Ouellette, *Do Patents Disclose Useful Information?*, 25 HARV. J.L. & TECH. 545, 586–96 (2012).

7. *See Nautilus*, 134 S. Ct. at 2128–31; *see also* Teva Pharm. USA, Inc. v. Sandoz, Inc., 135 S. Ct. 831, 836–43 (2015) (evaluating the standard of review for a claim construction that was the basis for the district court's decision on claim definiteness).

8. The dataset and the Stata files for creating the regressions presented here are available in the Duke Law Scholarship Repository at http://scholarship.law.duke.edu/dlj/.

9. The technologies, described in detail below, are (1) mechanical, (2) electrical, (3) chemistry, (4) biotechnology, (5) software (with subcategories 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 subcategories based on whether the litigation started 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. 1073, 1085–89 (2015) [hereinafter Allison et al., *Divided Patent System*]; John R. Allison, Mark A. Lemley & David L. Schwartz,

coded numerous control variables that might separately influence § 112 outcomes.

Our results include the following:

First, descriptive results reveal differences in outcomes on some § 112 issues for different technologies and industries. Among technologies, patents in the traditional fields of electrical, mechanics, and chemistry were less likely to be invalidated than patents in biotechnology, optics, and software in cases litigated to a decision. Perhaps surprisingly, software-implemented business-method patents were more likely to survive § 112 challenges than more technical software patents not covering business methods.

Among industry groups, our descriptive results also showed what appear to be meaningful distinctions: patents in the consumer goods and services, pharmaceuticals related to Abbreviated New Drug Application (ANDA) litigation,[10] construction, semiconductor, energy, and biotechnology industry groupings were less likely to be invalidated 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 were more likely to be invalidated. Notably, there was a large performance drop-off to the bottom two (computers/electronics and pharmaceuticals not involved in ANDA litigation).

Second, 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: electrical patents were less likely to be invalidated than those in other technology fields on written description and were bested only by mechanical patents on enablement. At the other end of the technology spectrum, software patents on inventions other than business methods fared poorly on enablement.

Understanding the Realities of Modern Patent Litigation, 92 TEX. L. REV. 1769, 1772–76 (2014) [hereinafter Allison et al., *Realities of Modern Patent Litigation*].

10. As explained below, litigation that starts with a generic manufacturer filing an ANDA may be different from non-ANDA-related pharmaceutical litigation, and the litigated patents themselves may be different on average. *See infra* note 131We thus report results both with all pharmaceutical litigation combined, and with it separated into ANDA and non-ANDA cases.

There were also only a few statistically significant differences across industry categories. Patents in the computer and electronics industry were very likely to be invalidated for lack of enablement after accounting for all of the other factors in our model. Patents in the pharmaceutical industry that were tested in litigation *not* triggered by a generic drug maker's filing of an ANDA also fared poorly on both written-description and definiteness grounds, likely because these patents mostly relate to various methods rather than FDA-approved drug compositions. On the other hand, 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.

Third, three other independent variables had significant (sometimes highly significant) correlations with litigated § 112 outcomes, regardless of technology or industry:

1. 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.

2. Decisions rendered after the Federal Circuit's decision in *Markman v. Westview Instruments*[11] (affirmed by the Supreme Court) were significantly more likely 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.

3. 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

11. Markman v. Westview Instruments, Inc., 52 F.3d 967 (Fed. Cir. 1995) (en banc), *aff'd*, 517 U.S. 370 (1996) (holding that interpretation of patent claims is for the court, not the jury). *Markman* gave rise to the eponymous "*Markman* hearing," which typically involves significant pretrial discovery and focuses on the interpretation of disputed terms in patent claims. *See* PETER S. MENELL ET AL., PATENT CASE MANAGEMENT JUDICIAL GUIDE 2-23 (3d ed. 2015), http://ssrn.com/abstract=2637605 [http://perma.cc/V4UC-5M84]. Because resolving disputes over the meaning of claim language is a prerequisite to decisions about patent validity and infringement, the results of *Markman* hearings are frequently outcome determinative. *See id.* at 2-30. Such hearings also have brought § 112 issues even more to the forefront than previously had been the case, because definiteness, enablement, and written-description issues all deal with the claims (as interpreted) and the written description and drawings (the "specification") that must provide adequate support for the claims. Trial judges sometimes make final rulings on claim-indefiniteness assertions as part of the orders that follow claim construction, although they may defer such decisions until the summary-judgment stage or until after trial. *See id.* at 5-100 to 5-101.

> claims drafted in means-plus-function[12] format were more likely than those drafted in other formats to be held indefinite.[13] The Federal Circuit embraced the use of indefiniteness to invalidate overbroad means-plus-function software patents in 2008 in *Aristocrat v. International Game*,[14] but the effect we observed persisted even when all software patents were removed from the dataset, and when we limited the analysis to pre-2008 decisions, revealing that this result is not purely driven by *Aristocrat*.

Fourth, a number of our control variables had little to no statistically significant effect on outcomes despite indications in prior research that some of these variables might have an influence on litigation outcomes. For example, 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,[15] and the foreign origin of an invention or a foreign priority filing by the patent applicant were not significantly associated with any different

---

12. A claim element "may be expressed as a means or step for performing a specified function," which then limits the claim to the "corresponding structure, material, or acts described in the specification and equivalents thereof." 35 U.S.C. § 112(f) (2012). "[A] means-plus-function clause is indefinite if a person of ordinary skill in the art would be unable to recognize the structure in the specification and associate it with the corresponding function in the claim." Noah Sys., Inc. v. Intuit Inc., 675 F.3d 1302, 1312 (Fed. Cir. 2012) (quoting AllVoice Computing PLC v. Nuance Commc'ns, Inc., 504 F.3d 1236, 1241 (Fed. Cir. 2007)).

13. One may find patent claims drafted to cover a machine, an apparatus or device, an "article of manufacture" (such as a product), a composition of matter (such as a chemical composition or composite with defined elements and proportions), or a method (a process or technique). It is common to find claims on the same invention drafted in more than one of these formats in the same patent, which is done for fail-safe purposes in light of the imperfect nature of language in describing anything with great precision.

14. Aristocrat Techs. Austl. Pty Ltd. v. Int'l Game Tech., 521 F.3d 1328 (Fed. Cir. 2008).

15. Prior research by John Allison, Mark Lemley, and David Schwartz showed that potential infringers who instituted the lawsuit first by filing an action for declaratory judgment of noninfringement and invalidity fared better on several specific outcomes (including winning the case outright) than when such parties asserted noninfringement and invalidity as defendants in a counterclaim when they were sued for infringement. Most notably, this result was independent of any effect on outcomes associated with the federal district in which the case was decided. *See* Allison et al., *Realities of Modern Patent Litigation*, *supra* note 9, at 1798. Unlike the present study, however, that research used a dataset of cases filed in 2008 and 2009 that resulted in substantive decisions by the end of 2013. *Id.* at 1769. It analyzed the results of ten separate litigation outcomes and used a different approach to coding those outcomes—namely, it based its coding on whether particular outcomes were favorable to the patent owner or the accused infringer and did not use an ordinal scale to assess the strength of outcomes as does the present study. *Id.* at 1792–94.

likelihood of a given § 112 outcome.[16] In addition, 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.

Finally, we reran all of our regressions with a continuous-year variable in addition to the post-*Markman* variable, which should capture whether doctrine shifted over time aside from the shift precipitated by *Markman*. Including this variable had little effect on our results.

Our Article proceeds in four Parts. In Part I, we review the conventional wisdom about how courts have applied § 112 to 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. Most importantly, while we are confident that our results show how courts have adjudicated patent disclosure and definiteness in cases that led to a reported decision (including denials of summary judgment), one must be cautious before generalizing from these results to broader populations. 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. In Part IV, we offer some suggestions about how these selection effects might affect § 112 outcomes. Despite this limitation, we think that even providing a detailed picture of the state of § 112 litigation in cases litigated to decision will enrich discussions of § 112 reform, and we hope that other researchers will use and build on our dataset for further empirical studies.

I. IS § 112 TECHNOLOGY SPECIFIC?

The Supreme Court often describes patents as bargains between inventors and society.[17] In return for the exclusive rights provided by a

16. Previous research showed that owners of patents covering foreign-origin inventions performed better than their U.S.-origin counterparts on some important outcomes. *See id.* at 1796–97.

17. *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

patent,[18] the inventor must teach others how to create the invention. In particular, section 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 claimed invention.[19] The former, commonly called the "enablement" requirement, and the latter, the "written-description" requirement, are closely related.[20] In addition, the patent bargain requires the inventor to clearly notify the public[21] of the exact contours of the property interest sought by writing "claims" that specify the invention with particularity and distinctness.[22]

These three requirements—enablement, written description, and definiteness—help ensure that the patent teaches other individuals

---

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." (quoting United States v. Dubilier Condenser Corp., 289 U.S. 178, 186 (1933))); *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 . . . .").

18. "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).

19. *Id.* § 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 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.

20. The Federal Circuit recently affirmed the existence of written description as a separate patentability requirement from enablement, *see* Ariad Pharms., Inc. v. Eli Lilly & Co., 598 F.3d 1336 (Fed. Cir. 2010) (en banc), although commentators have criticized this distinction, *see, e.g.*, Yu, *supra* note 5, at 911–19. We do not take a position in this debate; rather, we focus only on describing how the § 112 requirements have been applied in practice.

21. The "public" is that of relevant PHOSITAs.

22. "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).

skilled in the field what the invention is and how to reproduce it.[23] (Section 112 also requires that the patent "set forth the best mode . . . of carrying out the invention,"[24] but granted patents may no longer be invalidated for failure to disclose the best mode,[25] so we do not analyze this requirement here.)

The enablement and written-description requirements are closely related in that both seek to prevent a mismatch between the disclosures in the patent specification and one or more of the claims in that same document. For example, the greater the breadth 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 the claim.[26] The reverse is likewise true. But 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 applying inventor clearly had in mind the exact invention in a claim that is at

23. For a review of the disclosure requirements, see generally Ouellette, *supra* note 6, at 550–54 ("[T]his part briefly reviews the current legal standard for disclosure in the United States as interpreted by the Court of Appeals for the Federal Circuit.").

24. 35 U.S.C. § 112(a).

25. *Id.*

26. Failure to fulfill the written-description requirement occurs when that description does not "describe the invention sufficiently to convey to a person of skill in the art that the patentee had possession of the claimed invention at the time of the application, i.e., that the patentee invented what is claimed." LizardTech, Inc. v. Earth Res. Mapping, Inc., 424 F.3d 1336, 1345 (Fed. Cir. 2005). Violations of this disclosure requirement are more likely to occur 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. UNITED STATES PATENT AND TRADEMARK OFFICE, MANUAL OF PATENT EXAMINING § 2163.05 (9th ed. 2014) ("The failure to meet the written description requirement . . . commonly arises when claims are changed after filing to either broaden or narrow the breadth of the claim limitations, or to alter a numerical range limitation or to use claim language that is not synonymous with the terminology used in the original disclosure."). Although the details of prosecution strategy are far beyond the scope of this Article, in general, claims can be changed or 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 the specification cannot. *See, e.g.*, Monsanto Co. v. Scruggs, 459 F.3d 1328, 1337 (Fed. Cir. 2006) ("Nothing about a continuation or divisional patent makes it inherently more likely to fail the written description requirement or changes the burden of proof with respect to proving invalidity."). This fact leads to the very real possibility of a disconnect existing between the specification and a particular claim. *See, e.g.*, PIN/NIP, Inc. v. Platte Chem. Co., 304 F.3d 1235, 1247–48 (Fed. Cir. 2002) ("In this case, the originally filed application, which is devoid of any mention or even implication that the two chemicals can be applied in a spaced, sequential manner, does not support the later-added claim."). Statutory authority for continuing applications and requirements for retaining the earlier filing date are found in 35 U.S.C. § 120.

issue, thus fulfilling the written-description requirement, but did not supply enough detail about, for example, 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 resort to unreasonable experimentation.[27] 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.[28]

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 Instruments*[29] decision. For some time, the Federal Circuit had required that a claim need only be susceptible to construction and not "insolubly ambiguous" to satisfy the definiteness requirement.[30] Toward the end of its 2014 Term, however, the Supreme Court arguably abrogated this lax standard by calling for the language of a patent claim to delineate the invention such that a PHOSITA can understand its scope with "reasonable certainty."[31] Although the Court's language

27. 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, Note, *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 the enablement requirement).

28. 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, 1357 (Fed. Cir. 2004); Gentry Gallery, Inc. v. Berkline Corp., 134 F.3d 1473, 1479–80 (Fed. Cir. 1998); Fujikawa v. Wattanasin, 93 F.3d 1559, 1569–71 (Fed. Cir. 1996).

29. Nautilus, Inc. v. Biosig Instruments, Inc., 134 S. Ct. 2120 (2014).

30. *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. 643, 689–96 (2015).

31. *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

seems to call for imposition of a stricter definiteness requirement, its actual impact largely remains to be seen.[32]

The Patent Act contains no indication that these § 112 requirements should be applied differently to different technologies, and the international Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS)—which imposes minimum levels of IP protection on all members of the World Trade Organization (WTO)—prohibits "discrimination as to . . . the field of technology" in national patent laws.[33] Although some have doubted the wisdom of continuing the unitary model because of the different needs of innovators in different fields,[34] a move toward separate patenting rules for particular technologies or industries would produce unintended negative effects. For example, such an approach would inevitably lead to strategic drafting to fit more favorable technology classifications, which would further lead to increased transaction costs associated with tortuous drafting to make an invention appear to be something it is not.[35]

---

delineating the patent, and the prosecution history, fail to inform, with reasonable certainty, those skilled in the art about the scope of the invention.").

32. Although some 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 Article to engage in a doctrinal analysis of the decision's effect on lower-court rulings. For a discussion of how the Federal Circuit's treatment of indefiniteness may be slowly starting to change, see Lisa Larrimore Ouellette, Dow v. Nova*: Maybe* Nautilus *Does Matter*, WRITTEN DESCRIPTION BLOG (Aug. 28, 2015, 12:14 PM), http://writtendescription.blogspot.com/2015/08/dow-v-nova-maybe-nautilus-does-matter.html [http://perma.cc/UR5B-PB2A].

33. 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, https://www.wto.org/english/docs_e/legal_e/27-trips.pdf [https://perma.cc/99KB-PBVK].

34. *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, 672–73 (2014); Neel U. Sukhatme, *Regulatory Monopoly and Differential Pricing in the Market for Patents*, 71 WASH. & LEE L. REV. 1855, 1882–86 (2015). For a critique of the dominant push toward uniformity in patent law on policy-learning grounds, see generally Lisa Larrimore Ouellette, *Patent Experimentalism*, 101 VA. L. REV. 65 (2015).

35. *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, 786 (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. *Id*. A patent attorney is, of course, not wrong in doing this, and doing so 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

But many observers of the patent system have argued that "while patent law is technology-neutral in theory, it is technology specific in application,"[36] 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 but 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, particularly in more recent cases. 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.[37] Sean Seymore has similarly stated that "[i]n contrast to the applied sciences (like electrical and mechanical engineering), the judiciary has required more detailed disclosure in chemistry and the experimental sciences."[38] Dan Burk and Mark Lemley have repeatedly written about "stringent enablement and written description requirements on biotechnology patents that do

---

and waned. *Id*. Patent attorneys likely would be able to engage in such behavior often enough to meaningfully undercut attempted reforms based on explicit distinctions between different technologies or industries.

36. Burk & Lemley, *supra* note 4, at 1156; *see, e.g.*, Michael W. Carroll, *One for All: The Problem of Uniformity Cost in Intellectual Property Law*, 55 AM. U. L. REV. 845, 846–47 (2006); Roin, *supra* note 34, at 676.

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

38. 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, 282–83 (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").

not show up in other disciplines."[39] Many other scholars have picked up on this theme.[40]

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.[41] But many commentators suggest that the written-description standard in biotechnology is particularly rigid, with blame placed primarily on the Federal Circuit's 1997 decision in *Regents of the University of California v. Eli Lilly & Co.*[42] 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.[43] Treatise author Janice Mueller

39. Burk & Lemley, *supra* note 4, 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) [hereinafter Burk & Lemley, *Policy Levers*] (expressing the same sentiment).

40. For example, student notes have made assertions such as that "[t]he biotechnology and pharmaceutical industries, in particular, have become subject to more stringent written description requirements than other industries," 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), and that "heightened enablement and written description requirements for biotechnology" have "effectively eliminated patent protection for biotechnology inventions pertaining to proteins," Sheila R. Arriola, *Biotechnology Patents After* Festo*: Rethinking the Heightened Enablement and Written Description Requirements*, 11 FED. CIR. B.J. 919, 919 (2002). Similar examples are easy to find. *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."). Indeed, a search of Westlaw's law-journal database on January 4, 2015 for "heightened," "strict," or "stringent" enablement or written description in the context of biotechnology had over 100 results. *See* Law Reviews & Journals, WESTLAW, www.westlaw.com (follow "Secondary Sources" hyperlink; then search for [(enablement "written description") /s (biotech!) /s (heightened stringent strict)]).

41. *See, e.g.*, Seymore, *Heightened Enablement*, *supra* note 38, at 136–39.

42. Regents of the Univ. of Cal. v. Eli Lilly & Co., 119 F.3d 1559 (Fed. Cir. 1997).

43. *Id.* at 1566–67.

calls this "a significant departure from prior written description cases" that "sets a significantly higher standard for the protection of biotechnological inventions."[44] 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.[45] 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."[46]

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" such as mechanics and software, where a skilled artisan is more likely to be able to tell whether an invention works based simply on reading the patent.[47] 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

44. 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, 250 (2002) ("In [*Eli Lilly*], the Federal Circuit imposed a heightened 'precise definition' written requirement standard for claims to DNA.").

45. 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).

46. *Id.* at 1306 (Lourie, J., concurring in the denial of rehearing en banc) (citing *In re* Curtis, 354 F.3d 1347 (Fed. Cir. 2004) (applying "heightened" standards to a patent application for 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)).

47. 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).

"technology that would normally be considered to fall within the predictable arts."[48]

Finally, note that stringent *disclosure* requirements in biotechnology or chemistry do not 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."[49] 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."[50] Kathy Strandburg notes the "low standards for enablement and description" in software and business methods.[51] Other examples abound,[52] and we have not found any commentators who dispute this consensus.

---

48. Bernard Chao, *Rethinking Enablement in the Predictable Arts: Fully Scoping the New Rule*, 2009 STAN. TECH. L. REV. 3, ¶¶ 6–8, http://journals.law.stanford.edu/sites/default/files/stanford-technology-law-review/online/chao-rethinking-enablement.pdf [http://perma.cc/PCT7-KXLE] (discussing *Sitrick v. DreamWorks, LLC*, 516 F.3d 993 (Fed. Cir. 2008) (integration of audio or visual signal into video games or movies), *Automotive Technologies International, Inc. v. BMW of North America, Inc.*, 501 F.3d 1274 (Fed. Cir. 2007) (vehicle side-impact crash sensors), and *Liebel-Flarsheim Co. v. Medrad, Inc.*, 481 F.3d 1371 (Fed. Cir. 2007) (medical fluid-injection system)); Seymore, *Enablement Pendulum*, *supra* note 38, at 286–89 (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).

49. 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, 60 (2010).

50. Burk & Lemley, *Policy Levers*, *supra* note 39, at 1593, 1653–54; Burk & Lemley, *Technology-Specific*, *supra* note 4, at 1156 (expressing the same idea); Burk & Lemley, *Uncertainty Principle*, *supra* note 39, at 706–07 (showing that the written-description requirement in software is "antithetical" to that for biotechnology).

51. Katherine J. Strandburg, *Patent Fair Use 2.0*, 1 U.C. IRVINE L. REV. 265, 285 (2011).

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."[53] But this does not mean that one would expect to find fewer invalidations for indefiniteness in software than other fields—before *Nautilus v. Biosig*, the indefiniteness standard was generally viewed as "toothless" for all technologies.[54] But even before *Nautilus*, courts were using indefiniteness to curb a number of overbroad software patents,[55] even if not as often as some commentators would like.

C. Prior Empirical Work

The conventional wisdom about the application of § 112 to different 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, the volume of empirical literature on litigation outcomes is growing. Much of this work does not separate § 112 from other invalidity results.[56] Other works—including a study

---

52. *See, e.g.*, Ronald J. Mann, *Do Patents Facilitate Financing in the Software Industry?*, 83 TEX. L. REV. 961, 1026 (2005) (noting the "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) (identifying "software's low written description bar").

53. Lemley, *supra* note 2, at 945.

54. Ronald J. Mann, *Argument Preview: Justices To Wade into Morass About "Indefinite" Claims in Patents*, SCOTUSBLOG (Apr. 17, 2014, 11:51 AM), http://www.scotusblog.com/2014/04/argument-preview-justices-to-wade-into-morass-about-indefinite-claims-in-patents [http://perma.cc/FTK8-MDPR].

55. *See* Lemley, *supra* note 53, at 945–46 ("[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 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.").

56. *See* Colleen V. Chien, *Predicting Patent Litigation*, 90 TEX. L. REV. 283, 309 (2011) (comparing a randomly selected group of 659 litigated patents issued in 1990 with matched nonlitigated patents); Paul M. Janicke & LiLan Ren, *Who Wins Patent Infringement Cases?*, 34 AIPLA Q.J. 1, 4 (2006) (examining all 262 dispositive Federal Circuit decisions, including affirmances without opinion, from 2002 to 2004); Jay P. Kesan & Gwendolyn G. Ball, *How Are*

by one of us—have examined the separate § 112 doctrines, but do not classify cases by technology or industry.[57] But a few studies have begun to describe how § 112 is applied in different technologies. This Section briefly reviews this prior work.

Chris Holman considered 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.[58] As discussed above, many commentators viewed this decision as heightening the written-description requirement for biotechnology.[59] 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.[60] He qualitatively described the technology at issue in each case, but was able to conclude only that it remains unclear whether *Eli Lilly*'s written-description doctrine is "particularly directed towards biotechnology" or not.[61] Other studies that claimed to find

Patent Cases Resolved? An Empirical Examination of the Adjudication and Settlement of Patent Disputes, 84 WASH. U. L. REV. 237, 259 (2006) (examining about 6,300 patent cases filed in 1995, 1997, and 2000); Michael Risch, *The Layered Patent System*, 101 IOWA L. REV. (forthcoming 2016) (manuscript at 4–5), http://ssrn.com/abstract=2567415 [http://perma.cc/XK2D-4VY6] (comparing litigation outcomes from the most litigious nonpracticing entities with other randomly selected plaintiffs).

57. All published Federal Circuit patentability rulings over five different years were coded for validity outcomes in Lisa Larrimore Ouellette, *What Are the Sources of Patent Inflation? An Analysis of Federal Circuit Patentability Rulings*, 121 YALE L.J. ONLINE 347 (2011), http://www.yalelawjournal.org/forum/what-are-the-sources-of-patent-inflation-an-analysis-of-federal-circuit-patentability-rulings [http://perma.cc/GA8D-94GT]. Of these 324 cases, fifteen (5 percent) involved enablement (four valid/patentable, six mixed rulings, five invalid/unpatentable), thirty-two (10 percent) involved written description (eleven valid, nine mixed, twelve invalid), and twenty-eight (9 percent) involved indefiniteness (fourteen valid, five mixed, nine invalid). *Id.* at 357–59 (with section 112–specific outcomes drawn from the original data).

58. 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, 4–5 (2007) (searching for written-description cases citing *Eli Lilly* or any later Federal Circuit cases that applied the *Eli Lilly* rule). Dennis Crouch also examined written-description decisions of the BPAI in a subsequent study; 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).

59. *See supra* notes 42–46 and accompanying text.

60. Holman, *supra* note 58, at 26, 37, 42, 58, 70.

61. *Id.* at 80–81.

differences between technologies were similarly limited by small sample sizes.[62]

The most detailed data comes from an article in which one of us examined all substantive patent-litigation decisions in cases filed in 2008 and 2009 using the same technology and industry classifications reported here.[63] That 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,[64] making it difficult to draw any firm conclusions. That study is also limited to cases filed in only two years, rather than the much broader time range examined here.

---

62. 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 ten of fourteen chemical cases, in ten of sixteen electrical cases, and in eleven of seventeen other cases. 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). Although 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." *Id.* at 25. Indeed, the *p*-value for the observed difference between chemical and electrical cases is 0.61, meaning that even if there were no difference between the two groups of cases, there is a 61-percent chance that one would observe a difference in outcomes as large as the difference Laser observed simply due to random sampling error. Standard significance tests require *p*-values less than 0.05, or at least less than 0.10. David H. Kaye & David A. Freedman, *Reference Guide on Statistics*, *in* FED. JUDICIAL CTR., REFERENCE MANUAL ON SCIENTIFIC EVIDENCE 211, 251 (3d ed. 2011), http://www.fjc.gov/public/pdf.nsf/lookup/SciMan3D01.pdf/$file/SciMan3D01.pdf [http://perma.cc/UX7X-7N6K] ("The 5% level [of statistical significance] is the most common in social science, and an analyst who speaks of significant results without specifying the threshold probably is using this figure."). In another work, Dunstan Barnes examined 138 Federal Circuit opinions between 1997 and 2011 that reached the merits of a written-description or enablement issue. Dunstan H. Barnes, Note, *Technically Speaking, Does It Matter? An Empirical Study Linking the Federal Circuit Judges' Technical Backgrounds to How They Analyze the Section 112 Enablement and Written Description Requirements*, 88 CHI.-KENT L. REV. 971 (2013). He reported that for the forty biotechnology patents the invalidation rate was 62.5 percent and that for the ninety-eight other patents it was 58.2 percent. *Id.* at 1006. Barnes erroneously reported that this difference was "statistically significant ($p < 0.05$) under Pearson's chi-squared test." *Id.* The *p*-value under the chi-squared test is actually 0.64.

63. Allison et al., *Divided Patent System*, *supra* note 9.

64. *Id*. at 70–88.

II. DATA AND METHODOLOGY

A. Data Collection

In this Article, we seek to test empirically the conventional wisdom that courts have applied § 112 requirements disparately across different technologies and industries. To do so, we collected all § 112 decisions in the Westlaw database 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.[65] We began with an intentionally overinclusive dataset of all cases in which § 112 had been referred to in any way, and then we culled all cases that did not include an actual ruling on an accused infringer's challenge to the validity of a utility patent asserted in litigation (including validity challenges by declaratory-judgment plaintiffs).[66] We focused only on validity challenges in the litigation context; we did not include appeals from reexamination or reissue proceedings at the U.S. Patent and Trademark Office (PTO). We included denials of summary judgment when these were the last-recorded decisions. Federal Circuit cases decided between July 2012 and September 10, 2014, were added to this collection.[67]

We tried to achieve a complete census of reported § 112 decisions during this period rather than taking a sample. Of course, not all decisions are reported in Westlaw; although its database includes many unpublished decisions, its coverage is slightly less comprehensive for district court cases and for older cases.[68] But within

65. Had Lex Machina's database of patent cases included those filed closer to the starting date of our desired population rather than starting in 2000, 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 9, at 1772–73.

66. We only collected cases involving utility patents, the ordinary twenty-year patents for new inventions, and not design patents or plant patents.

67. We did not add more recent district court decisions because we could not be confident that appeals in these cases would be resolved by the time we began our analysis. Also note that four of the more recent Federal Circuit decisions were decided after the Supreme Court's June 2, 2014 decision on the definiteness requirement in *Nautilus*. In these four cases, the court rendered claim-definiteness decisions on seven patents. We decided to include these seven patent-case pairs in our dataset because the research question we sought to answer empirically is whether district courts and the Federal Circuit have over time applied the three section 112 patentability requirements disparately *across technologies and industries*, irrespective of doctrinal changes in one of these requirements.

68. *See* E-mail from Tedd C., West Reference Attorney, to Lisa Larrimore Ouellette, Asst. Prof. of Law, Stanford Law School (July 18, 2015, 6:41 PM) (on file with author); E-mail from

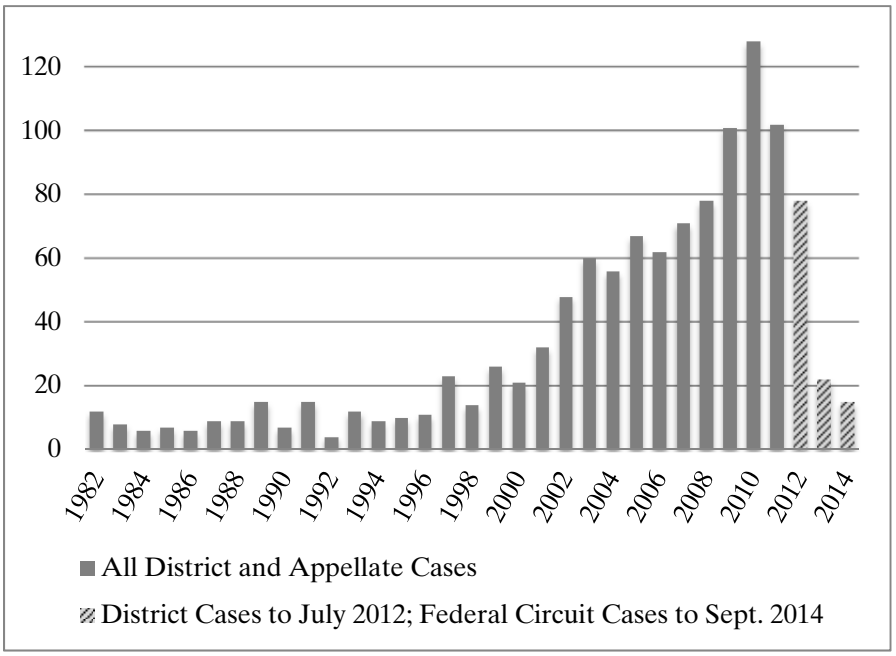
this limitation, we emphasize that our data set is a population, not a sample—a population of patents on which one of the three § 112 issues was litigated to a merits decision reported in Westlaw between January 1, 1982, and July 31, 2012 (and up to September 10, 2014, for Federal Circuit cases). Thus we are not inferring things about a population from a sample drawn from that population. Any differences between technologies and industries in a population are significant by definition. We have, however, performed regression analyses and tests for statistical significance as though we were drawing inferences from a sample because many readers may seek to extrapolate these results to times outside our data set's date parameters. Because we study a population, though, examining the coefficients in our results and noting both their direction and magnitude may be a useful exercise even when these coefficients are not statistically significant—any observed differences in a population are real ones.

Figure 1 displays the size of our dataset by year. 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 1144 in our dataset (with individual patents separated into groups of claims in the few cases for which courts reached different decisions on different claims within the same patent).[69]

Scott S., West Reference Attorney, to Lisa Larrimore Ouellette, Asst. Prof. of Law, Stanford Law School (July 19, 2015, 9:57 PM) (on file with author).

69. The few instances in which courts rendered different decisions for different claims within the same patent typically involved claim definiteness; in these instances, we created more than one row in our spreadsheet for the same patent. These additional decisions are counted within the total 1144 observations.

Figure 1. § 112 Patent-Case Pairs in Westlaw by Year (Total = 1144)



B. Case Outcomes

As noted above, our dataset contains 1144 patent-case pairs. Some patent-case pairs in our dataset include decisions on more than one of the three § 112 requirements for the same patent, so the total number of separate *decisions* is actually 1405. 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 under § 112 at trial, we do not report the earlier decision on summary judgment.[70] The same

70. If a court rejects a section 112 invalidity argument but the patent is invalidated on other grounds (in the same opinion or later), we include the patent in our sample as not invalid under section 112.

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. Our dataset does not include Federal Circuit summary affirmances without opinion, but the district court decision being affirmed will be in our dataset as long as it is reported, which will typically be the case.[71]

Determining exactly what an "outcome" is when empirically studying litigation, particularly patent litigation, is notoriously difficult. As noted, we seek to resolve one of the inherent difficulties by coding 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 five-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. (Technically, a patent is found "not invalid" rather than "valid,"[72] but for simplicity we will refer to rulings of validity.)

We also created a coarser one-to-three 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 three-level scale in ascending order of decision strength in the patent owner's favor is (1) invalid, (2) fact issue remaining, and (3) valid (not invalid).

We coded a decision as one made as a matter of law, whether for validity or invalidity, if a district court granted summary judgment or pre- or postverdict judgment as a matter of law (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

71. Under Rule 36, the Federal Circuit "may enter a judgment of affirmance without opinion" when the judgment below is supported by the record. Fed. Cir. R. 36. The Federal Circuit is thus unlikely to use Rule 36 when the decision below was so cursory as to be excluded from Westlaw.

72. "Valid" means "not invalid" because the court's ruling is merely that the challenger has not met its burden of proving invalidity. 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 Tex. Holdings Corp., 498 F.3d 1290, 1297 (Fed. Cir. 2007).

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 preverdict 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 preverdict 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 used the flag service to update all Federal Circuit decisions as well. It is thus 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 Article 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 technology is put to use. In one instance, biotechnology, we use the same term to describe both a technology and an industry; a patent on a gene sequence used in gene therapy is both a biotech technology and is used in the biotech industry. The two are not, however, identical. About half of the patents covering biotechnology techniques, that is, 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.

Although the PTO has a technology-classification scheme, it was not created for the purpose of defining technologies at a conceptual level[73] and possesses other serious shortcomings, as one of us has discussed in prior work.[74] Instead, 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.[75]

1. *Technologies*. When determining the technology area to which an invention should be assigned, we focused on the claims, because the invention is most precisely described therein. When a patent owner sues for infringement, the allegation is that the defendant has made, used, or sold a product (or machine, composition of matter, or process) that performs all of the functions specified in one or more designated *claims* in the patent. To determine exactly what the patent covers and to which technology area it belongs, one must therefore study the language of the claims. Do the claims exclusively, or at least primarily, refer to mechanical elements, or do they refer to electrical, chemical, data-processing, or optical elements? The written description and drawings (the specification) are in a patent for the purpose of clarifying claim language, and for teaching a person having ordinary skill in the "art" (the technical field) how to make and use the invention. Consequently, when necessary to fully understand a

73. U.S. PATENT & TRADEMARK OFFICE, OVERVIEW OF THE U.S. PATENT CLASSIFICATION SYSTEM (USPC), at I-1, I-3 (Dec. 2012), http://uspto.gov/sites/default/files/patents/resources/classification/overview.pdf [http://perma.cc/R4LW-GLDM] ("The [U.S. Patent Classification System] serves both to facilitate the efficient retrieval of related technical documents and to route patent applications within the USPTO for examination.").

74. *See, e.g.*, John R. Allison, Mark A. Lemley, Kimberly A. Moore & Derek Trunkey, *Valuable Patents*, 92 GEO. L.J. 435, 472 (2004) ("Because they are designed to assist in narrowly-tailored prior art searches, the government's classifications focus on the functional rather than the conceptual and do so at very low levels of abstraction."). When a researcher works with an extremely large dataset 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.

75. For the two most recent papers using these technology and industry areas, see generally Allison et al., *Divided Patent System*, *supra* note 9; and Allison et al., *Realities of Modern Patent Litigation*, *supra* note 9.

term in a patent claim, we resorted first to the specification. Occasionally, we also consulted technical dictionaries, encyclopedias, and the Internet to ensure that our understanding was correct. We first assigned each patent in our dataset to a single, *primary* technology area. For approximately one-sixth of the patents, we also identified one (or, rarely, two or more) *secondary* technology areas when another technology area clearly formed a secondary but nonetheless essential part of a claim or claims in the patent.[76] When only primary technology areas are counted, we made the same

---

76. One example is Air Flow System for Common Cavity Microwave Oven, U.S. Patent No. 4,028,520 (filed Feb. 26, 1976), which primarily covers the mechanical structure of a microwave oven. '520 Patent. The claim language also covers the control means, however, which is either electrical circuitry or an integrated circuit, which are electrical elements. '520 Patent. We classified the patent as being in the primary mechanical-technology and secondary electrical-technology areas. (If the control means covers an integrated circuit, there is no claim language covering the manipulation of data—data processing—and thus software is not a proper secondary technology category.)

A second example is Odor Control Device, U.S. Patent No. 4,830,791 (filed Feb. 29, 1988). Within this patent, Claim 1 reads:

> 1. An improved odor control device including a basic support structure, power means, means for creating air-movement driven by said power means, a source of deodorizing olfactory stimulating means, means for determining the operation of said means for creating air-movement whereby the status of operability of said power means can be ascertained, means for determining a predetermined life span based on the operation of said device, the normal life of said deodorizing olfactory stimulating means being substantially equal to said predetermined life span, wherein said means for determining said predetermined life span includes a timer, a separate power source for driving said timer, said timer generating periodic pulses at predetermined intervals, a counter means accepting said periodic pulses, said counter means generating a latch signal upon receipt of a predetermined number of periodic pulses, signal means activated by said latch signal for notifying the user of said odor control device of the need for replacement of said deodorizing olfactory stimulating means.

'791 Patent, col. 5 l. 65 to col. 6 l. 16.

Because the claim includes several means-plus-function elements, it was necessary to study the written description for the purpose of ascertaining exactly which means were used to accomplish the stated functions. Combining the claim language and the explanations in the written description, one can see that the claimed invention, an improved deodorizer for urinals in public restrooms, consisted primarily of electrical elements, including "state of the art [electrical] circuitry," a timer, and a motor. '791 Patent. Claim 4 for the odor-control invention, however, described a

> means for permitting operation of said device only when subjected to a light source includes a light sensing device having the capability of providing an off or an on signal, respectively, in the absence or presence of a light source, means for amplifying the signal from said light sensing device connected to said power source and to said motor, thereby conserving the power source for use only when said light sensing device is subjected to light as when someone turns on a light in an enclosed room wherein said odor control device is located.

'791 Patent, col. 6 ll. 28–39. In other words, the invention was primarily electrical in nature, but with a secondary but critical optical element—the light sensor that conserved power by turning the electrical device on and off when light was present or not. Thus, we assigned the patent to primary electrical and secondary optical-technology classifications.

number of observations (1144) as the number of patent-case pairs. When both primary and secondary technology areas are included, the 1144 patent-case pairs included a total of 1330 technology areas for an average of 1.16 technology areas per patent-case pair. The six primary technology areas are thus mutually exclusive, while the primary-plus-secondary areas are not. The technology areas are defined as follows:

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

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

(3) Chemistry: An invention in which the claims cover chemical reactions, chemical compounds with specific elements and proportions, and chemical processes specifying 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.[77] Although a number of different genetic-

77. We also employ the term "biotechnology" to describe an industry in which 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. First, many of the patents assigned to biotechnology as a technology category find their way into the pharmaceutical-industry category, which is discussed below. This occurs when the result employing the scientific techniques of biotechnology (the technology) is a therapeutic drug. Second, when the technology of biotechnology produces a means for diagnosing a disease or disease propensity, however, the patent is properly assigned to a "medical" industry category. Finally, when a patent with a technology classification of biotechnology represents an advance in the science of biotechnology itself, its proper industry home is biotechnology.

engineering techniques exist, for several reasons we decided not to separate these techniques into distinct technology areas.

(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 patents claiming automated generation of customer proposals, advertising, financial techniques, the use of online catalogs, and so on.[78] 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.

---

78. An example is Billing System, U.S. Patent No. 5,287,270 (filed Dec. 2, 1992). Self-explanatory claim 1 in this early business-method patent states:

> 1. A system for presenting information concerning the actual cost of a service provided to a user by a service provider, said system comprising: storage means for storing individual transaction records prepared by said service provider, said transaction records relating to individual service transactions for one or more service customers including said user, and the exact charges actually billed to said user by said service provider for each said service transaction; data processing means comprising respective computation hardware means and respective software programming means for directing the activities of said computation hardware means; means for transferring at least a part of said individual transaction records from said storage means to said data processing means; said data processing means generating preprocessed summary reports as specified by the user from said individual transaction records transferred from said storage means and organizing said summary reports into a format for storage, manipulation and display on a personal computer data processing means; means for transferring said individual transaction records including said summary reports from said data processing means to said personal computer data processing means; and said personal computer data processing means being adapted to perform additional processing on said individual transaction records which have been at least in part preprocessed by said data processing means utilizing said summary reports for expedited retrieval of data, to present a subset of said selected records including said exact charges actually billed to said user.

'270 Patent col. 31 l. 39 to col. 32 l. 6.

The numbers of observations across primary technology areas only are reported in Figure 2, which divides the software category into non-business-methods software (that is, 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 3 reports the number of observations across primary- plus secondary-technology areas combined.

Figure 2. Observations Across Primary Technology Areas (Software Shown Both Combined and Divided into Nonbusiness Methods and Business Methods) (Total = 1144)

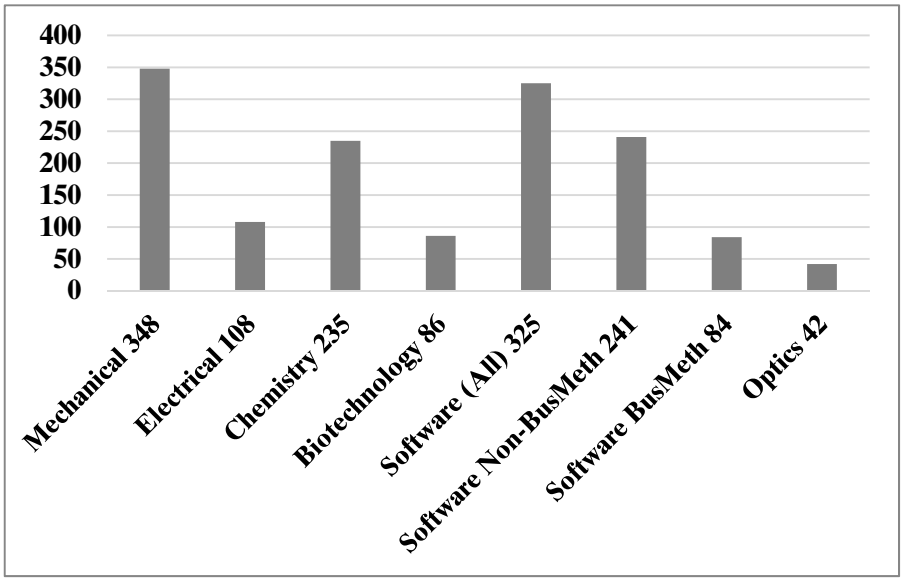
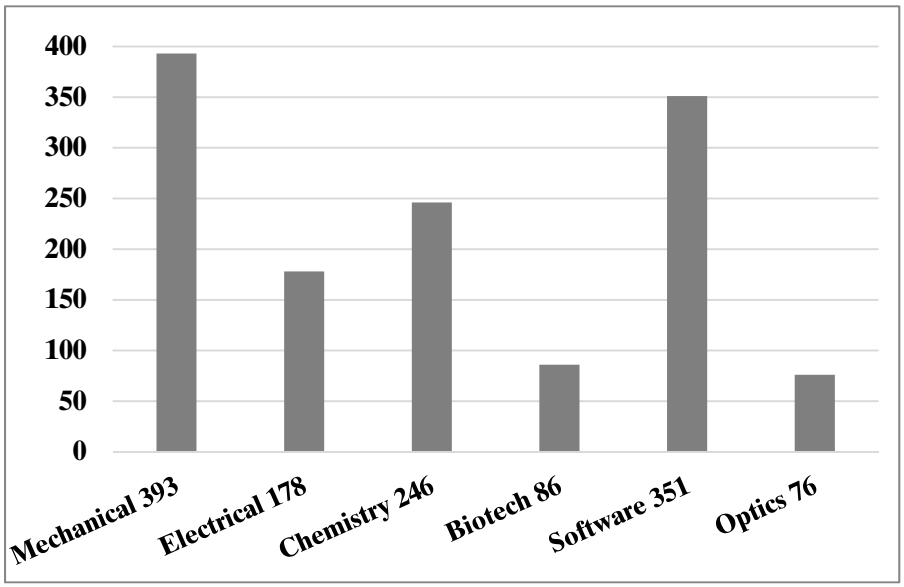


Figure 3. Observations Across Primary and Secondary Technology Areas Combined (Total = 1330 (1.16 per patent))



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

(1) Computer and Other Electronics: This industry encompasses inventions that purport to advance the state of the art in computing or computer-device manufacturing, or to enhance users' experiences in using computing technology. The category includes software and computer hardware, as well as inventions for which the advance involves traditional electrical circuitry. Most patents in this industry category fall in the electrical- or software-technology categories, but the mechanical and optics technologies are also represented. We combine the computer and traditional electronics industries because the industries clearly have been merging, with fewer and fewer patents covering traditional electronics and not also including data-processing elements.

(2) Semiconductor: The semiconductor-industry category includes inventions intended to advance the state of the art in researching, designing, or fabricating semiconductor chips. All technology areas except biotechnology are represented in this industry category.

(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) patent-case pairs in which the litigation was triggered by a generic drug manufacturer's filing of an ANDA under the Hatch-Waxman Act of 1984[79] and (b) those in which the litigation was not triggered by an ANDA filing.[80] We run some regressions using the

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

80. There are many examples of claims from pharmaceutical patents involved in ANDA litigation. *See generally, e.g.*, Ortho-McNeil Pharm., Inc. v. Mylan Labs. Inc., Nos. 04-1689, 06-757, 2006 WL 2865469 (D.N.J. Oct. 5, 2006) (granting plaintiff's motion for partial summary judgment on defendant's section 112 invalidity defenses); SmithKline Beecham Corp. v. Apotex

pharmaceutical-industry category as a whole and others in which ANDA and non-ANDA cases are treated as separate industry categories.

(4) 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.

(5) Medical Devices, Methods, and Other Medical: This industry category includes any inventions 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. Thus, this category does not include patents on processes or products for pharmaceutical purposes or patents using biotechnology techniques to advance the science of biotechnology without direct medical applications. All of the different technology fields are represented in the medical-industry category.

(6) Communications: The communications-industry category includes inventions in any technology—including software, electrical, optics, and mechanical—that advance the state of the art in communications. Software inventions pertaining solely to the technical aspects of communication within a computer network are not included within this industry category, and are placed instead in the computer-and-other-electronics classification.

(7) Transportation (Including Automotive): This category includes patents 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

---

Corp., 286 F. Supp. 2d 925 (N.D. Ill. 2001) (granting plaintiff's motion for partial summary judgment on the issue of validity and denying defendant's cross-motion on issues of invalidity, including indefiniteness under section 112, and noninfringement); Imperial Chem. Indus. PLC v. Danbury Pharmacal, Inc., 777 F. Supp. 330 (D. Del. 1991) (holding patent invalid on grounds of obviousness and failure to include an adequate disclosure under section 112).

There are also many examples of those patents assigned to the pharmaceutical-industry category, the litigation of which were *not* triggered by an ANDA filing. *See generally* N. Am. Vaccine Inc. v. Am. Cyanamid Co., 7 F.3d 1571 (Fed. Cir. 1993); Oakwood Labs. v. Tap Pharm. Prods., Inc., No. 01 C 7631, 2003 WL 22400759 (N.D. Ill. Oct. 21, 2003); Liposome Co. v. Vestar Inc., No. 92-332-RRM, 1994 WL 738952 (D. Del. Dec. 20, 1994). However, litigation over pharmaceutical compositions are not always triggered by ANDA filings. For one example of a patent on a pharmaceutical-drug composition for which a § 112 issue was litigated in a case not resulting from an ANDA filing, see generally Warner-Lambert Co. v. Teva Pharm. USA, Inc., No. 99-922(DRD), 2007 WL 4233015 (D.N.J. Nov. 29, 2007).

transportation services. The mechanical-, electrical-, chemistry-, and software-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.

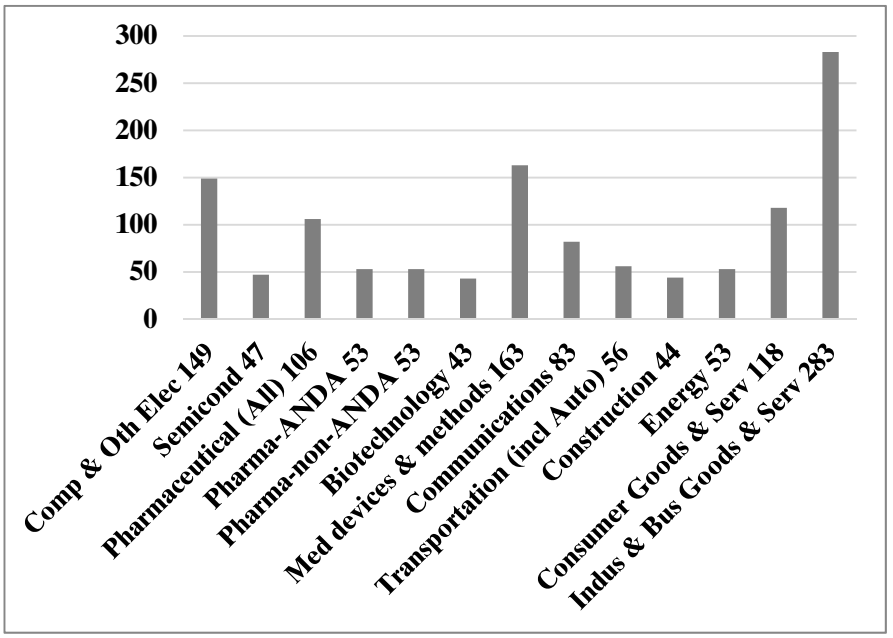
(9) Energy: This category includes inventions of any kind associated with sources of energy and with power generation, transportation, or consumption.

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

Figure 4 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 by an ANDA filing.

Figure 4. Observations Across Industry Categories (Total = 1144)



To help make this abstract discussion of coding patent-case pairs by outcome, technology, and industry more concrete, here is an example of a patent claim that was coded in our "mechanical" technology category and our "medical-device/methods" industry category. It illustrates the difficulty in precisely describing even a purely mechanical invention—here, 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.[81]

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.[82] After concluding that none of the disputed terms had a customary meaning and that the patent owner had chosen to be "its own lexicographer" (that is, had defined its own terms in the specification), the district court found all terms to be not indefinite as a matter of law.[83] This patent-case pair was thus coded as a five on our five-level indefiniteness scale (and a three on the collapsed three-level scale), and it does not factor into our enablement or written-description results.

D. Other Variables

Out of our 1144 patent-case pairs, 191 involve inventions with a non-U.S. origin (reported in our regressions as "foreign origin"). Invention origin was determined based on where the majority of inventors resided, or, if there was no majority, a plurality. In unusual cases in which there was a tie between 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 issuance.

There are 146 patent-case pairs in which the patent has a non-U.S.-priority filing ("foreign priority") and 998 with a U.S.-priority filing. This variable and the "foreign-origin" variable are strongly positively correlated, as one would expect, but a number of patents in our dataset have different invention origins and priority filing countries (often for inventions that originated in Canada or Israel but

81. Flexible Expandable Stent, U.S. Patent No. 6,443,982 col. 7 ll. 18–47 (filed Jan. 21, 2000).

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

83. *Id.*

with applications that were first filed in the United States). Of the 146 non-U.S. priority filings, the largest number were in the United Kingdom with thirty-eight, followed by Japan with twenty-six, Germany with twenty-two, France with sixteen, and Israel with eleven.

Only thirty-six of our patent-case pairs included reissue patents; the remaining 1178 were regular utility patents.[84] Our dataset includes 354 appeals court decisions and 790 decisions from district courts.[85] In addition, 1022 decisions in our study were rendered after the April 5, 1995 date of the Federal Circuit's decision in *Markman v. Westview Instruments, Inc.*, whereas 122 were made before that date. We discuss this case briefly and how we control for its possible effects on our outcomes 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). The top three districts had a substantially greater number of filings than the rest of the districts; the fourth busiest, the Northern District of Illinois, accounted for only sixty-six of the decisions.

III. RESULTS

We first present the overall outcomes for the three § 112 requirements, followed by a report and explanation of detailed descriptive results by technology and industry. After 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.

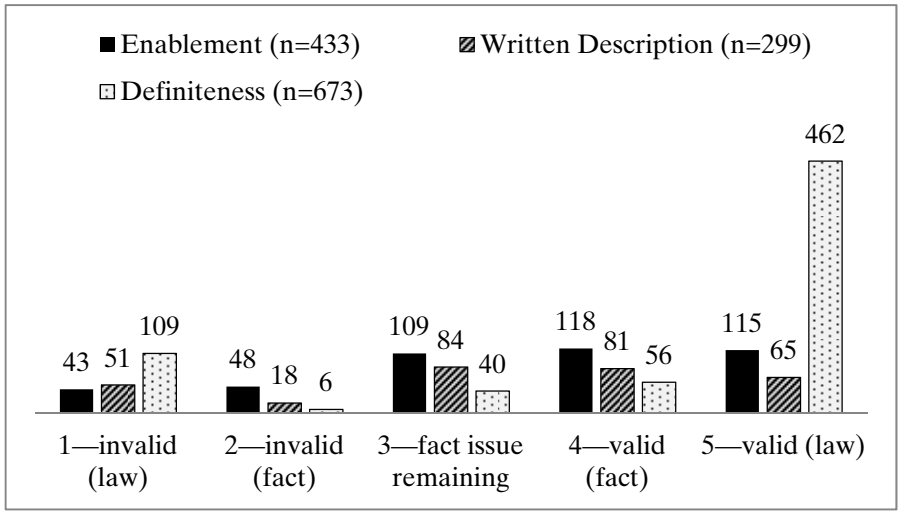
84. If a patentee can prove that, because of a good faith mistake, it claimed either less than or more than its specification supported, it can apply for a reissue patent. *See* 35 U.S.C. § 251(a) (2012). A patent owner can seek a reissue patent with *narrower* claims at any time during the patent's term of protection, but can only seek one with *broader* claims within two years after issuance of the original patent. *Id.* § 251(d). A reissue patent has only the term of protection that the original patent would have had. *See id.* § 251(a) ("[T]he Director shall . . . reissue the patent for the invention disclosed in the original patent . . . for the unexpired part of the term of the original patent.").

85. Four early appellate decisions in our dataset were by regional circuit courts. We kept these in the dataset because we believed that any disparate application of section 112 requirements would likely have been found in the early 1980s.

A. Overall Outcomes

Figure 5 shows the number of cases with each outcome on our five-level scale for each of the § 112 doctrines of issue: enablement, written description, and claim definiteness. The most common cases are those in which the court rejected as a matter of law an argument that a claim was indefinite. This may be because courts have been 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. It will be interesting to see whether this will change in light of the Supreme Court's recent *Nautilus* decision, discussed above.[86]

Figure 5. Overall Outcomes



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 five-level and the coarser three-level scales. Lower numbers mean that more patents in that category were invalidated; higher numbers mean that more results favored the patentee. Both lower and higher scores

86. *See supra* notes 29–32 and accompanying text.

also reflect our distinction between decisions made as a matter of law and those made as a factual matter: decisions of *invalidity* as a matter of law push the overall score *lower* than those made only after factual determinations, and decisions of *validity* as a matter of law push the score *higher* than those made only after factual determinations.[87] These raw scores do not account for the influence of other factors; we add controls for numerous variables in our regression results. Table 1 shows descriptive statistics by primary technology and issue, and Table 2 by primary-plus-secondary technology areas combined. Scores on the three-level scale follow the same pattern as the five-level scale, so we focus here on the more fine-grained five-level scale; the coarser scale has its greatest utility later as a robustness check on the regression results.

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	3.85	2.54	3.40	2.34	4.36	2.73
	sd	1.14	0.71	1.34	0.79	1.27	0.64
Electrical	**N**	49	49	30	30	64	64
	mean	3.63	2.45	3.97	2.63	4.11	2.63
	sd	1.25	0.77	0.93	0.62	1.46	0.74
Chemistry	**N**	110	110	58	58	128	128
	mean	3.51	2.36	3.38	2.33	4.16	2.62
	sd	1.26	0.79	1.30	0.85	1.36	0.72
Biotechnology	**N**	44	44	40	40	30	30
	mean	3.34	2.30	3.15	2.15	4.30	2.70
	sd	1.29	0.85	1.46	0.86	1.39	0.70
Software (All)	**N**	73	73	74	74	235	235
	mean	2.92	1.86	2.96	2.03	3.88	2.45
	sd	1.26	0.81	1.41	0.79	1.72	0.87
Software (Not BusMeth)	**N**	60	60	50	50	173	173
	mean	2.82	1.80	3.12	2.16	3.97	2.50
	sd	1.24	0.82	1.41	0.79	1.64	0.83
Software (BusMeth)	**N**	13	13	24	24	62	62
	mean	3.39	2.15	2.63	1.75	3.61	2.31
	sd	1.26	0.69	1.38	0.74	1.90	0.95
Optics	**N**	20	20	9	9	21	21
	mean	3.10	2.15	3.22	2.11	4.24	2.67
	sd	1.33	0.81	0.97	0.78	1.45	0.73

87. *See supra* note 72 and accompanying text (explaining "valid" means "not invalid").

The last two columns of Table 1 show that patents in the mechanical-, electrical-, chemistry-, biotechnology-, and optics-technology fields were most likely to withstand claim-indefiniteness challenges, with software having fared less well, and software's business-method subset being the most likely to be invalidated. Even software-implemented business methods, however, had an average score of well above three on our five-level scale, meaning that the average outcome was more favorable to the patent's validity than "fact issue remaining." The mean descriptive score on claim definiteness regardless of technology is a rather high 4.12, indicating that the average patent in our study contested for indefiniteness received a ruling above the level of "fact issue followed by a validity ruling." The mean of the six technology means for definiteness is 4.74 (which is higher than averaging over all patents because a greater numbers of patents in technology categories fared better against definiteness challenges). Across all technologies, patents were more likely to be invalidated on enablement and written description than on definiteness, with mean scores on the five-level scale of 3.49 and 3.30, respectively. That is, the average patent challenged on enablement or written description received a ruling between "fact issue remaining" and "fact issue followed by a validity ruling," with patents slightly more likely to survive enablement challenges. Although this difference is statistically significant, it is small and likely driven by the kinds of patents challenged under each doctrine. If instead of averaging over all patent-case pairs we take the average of the six technology means, the outcome is reversed: we get 3.39 for enablement and 3.46 for written description.

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 were more likely to be invalidated than those covering business models and techniques.[88] Unlike the rest of the software class,

88. This counterintuitive result accords with Michael Risch's study comparing litigation outcomes for the most litigious nonpracticing entities with other randomly selected plaintiffs, which found that hardware-specific software patents performed worse than general-purpose software patents. *See generally* Risch, *supra* note 56 and accompanying text.

business methods were ranked almost as high as biotech and above optics in their likelihood to survive scrutiny.[89]

On written description, patents in the electrical- and mechanical-technology areas switched places, the former being the most likely to withstand challenges. The mean written-description outcome for software business methods was the worst mean outcome for any technology on any § 112 issue, meaning that software-business-method patents were very likely to be invalidated for lack of written description. Non-business-method software and software as a whole also fared poorly on written description. Biotechnology underperformed the all-technology mean for written description and just barely outranked software as a whole and non-business-method software. Optics was next, followed in ascending order by chemistry and mechanical patents.

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	3.75	2.48	3.39	2.32	4.32	2.71
	Sd	1.22	0.75	1.37	0.81	1.30	0.67
Electrical	N	81	81	48	48	100	100
	mean	3.41	2.31	4.00	2.69	4.04	2.56
	Sd	1.29	0.79	0.88	0.59	1.55	0.80
Chemistry	N	114	114	61	61	135	135
	mean	3.52	2.38	3.39	2.34	4.16	2.62
	Sd	1.24	0.78	1.27	0.83	1.37	0.72
Biotechnology	N	44	44	40	40	30	30
	mean	3.34	2.30	3.15	2.15	4.30	2.70
	Sd	1.29	0.85	1.46	0.86	1.39	0.70
Software	N	85	85	81	81	252	252
	mean	3.01	1.93	3.01	2.06	3.93	2.48
	Sd	1.31	0.81	1.37	0.78	1.69	0.85
Optics	N	34	34	19	19	41	41
	mean	3.15	2.09	3.42	2.21	4.27	2.68
	Sd	1.31	0.79	1.35	0.79	1.36	0.69

89. Note that the mean scores are least reliable for optics and business methods because of the smaller numbers of observations. The standard errors of the means in each of these categories are about 0.3.

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 mechanical inventions involve structures and concepts that may be more easily grasped by lawyers, judges, and juries than inventions in other fields, which may contribute to the relatively greater degree of success when confronted with § 112 challenges of any kind.

Mean five-level scores on the three § 112 patentability requirements *combined* provide a somewhat different lens through which to compare the six technology areas. In Table 3, we averaged the three mean scores from the five-level scale for each technology area, with the primary technology areas from Table 1 in the first column of means and the primary and secondary technology areas combined from Table 2 in the second column. When the three § 112 issues are combined, electrical and mechanical patents fared the best, followed by chemistry, biotechnology, optics, and then software.

Table 3: Mean Scores on Five-Level Scale Across All § 112 Requirements Combined

	Primary Technology Area	**Primary + Secondary Combined**
Electrical	3.90	3.82
Mechanical	3.87	3.82
Chemistry	3.68	3.69
Biotechnology	3.60	3.60
Optics	3.52	3.61
Software (All)	3.25	3.32
All-Tech Mean	3.64	3.64

2. *Regression Results by Technologies and Issues.* From a purely descriptive perspective, it appears that the average outcome courts reach on the § 112 requirements has varied across technology fields. Such a conclusion is premature, however, without using multiple regressions to test the significance of these differences while controlling for other factors that could have influenced the outcomes.

Table 4 presents summary regression findings for primary and secondary technology areas combined, and then primary areas alone, for each of enablement, written description, and claim definiteness. All regressions used the ordered logistic regression (or ordered logit) model,[90] with standard errors calculated using the bootstrap method with clustering at both the patent and case levels.[91]

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.[92] Only outcomes measured by the

90. 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 one to three or one to five 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.

91. We clustered on the standard errors of both patents and cases simultaneously because (1) observations coded from the same patent litigated in multiple cases are likely to be correlated and (2) observations coded from multiple patents litigated in the same case are also likely to possess a degree of interdependence, given that the same decisionmaker rules on these patents and some of the patents asserted in the same case typically have come from the same original patent application. Any interdependence among separate observations causes them to convey less new information than if they were completely independent. Standard-error clustering is an accepted technique for use when the assumption of observational independence does not hold, as in many empirical studies of patent-infringement litigation. *See id.* at 85–86; A. Colin Cameron, Jonah B. Gelbach & Douglas L. Miller, *Robust Inference with Multi-way Clustering* 2 (Nat'l Bureau of Econ. Research, Tech. Working Paper No. 327, 2006), http://www.nber.org/papers/t0327.pdf [http://perma.cc/6F7F-7Q3K].

The bootstrap method provides an accurate estimate of standard errors when the underlying distribution is unknown by running the regression on random samples of the data many times. *See* LONG & FREESE, *supra* note 90, at 127. 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 1000 times. The coefficients from the 1000 regressions were used to derive a final *p*-value and standard error for each coefficient. We followed the same procedure separately for the written-description and claim-definiteness issues, the size of each resampling being the number of observations for that particular issue (that is, 299 and 673, respectively). Also, separate regressions using identical techniques were run for the five-level and three-level models on each issue.

92. 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

five-level scale are reported in Table 4; outcomes on the coarser three-level scale are included in the Appendix along with other more detailed findings.

We also used a linear probability model on a binary "valid" or "invalid" outcome variable, which was created by omitting the "fact issue remaining" category from the three-level outcome variable. The results of this set of regressions on the three § 112 issues are reported in the Appendix in Tables A10 and A11. These results are generally consistent with our more fine-grained measures.

In addition to regression results for specific technology areas and industry categories, Appendix tables report the results of *F*-tests for joint technology effects and joint industry effects, that is, whether technology area or industry category matters overall.[93]

In Table 4, coefficients appear first; in parentheses just below each coefficient is the corresponding *p*-value, which indicates how statistically significant the results are.[94] For example, $p=0.05$ indicates that if there were only random differences between patents in that category and in the comparison group, there is only a 5-percent chance that one would find an effect as large as the one observed.[95] A statistically significant result simply indicates that there is likely a nonrandom difference between that group of patents and other patents in the sample. (But note that even if the data are random, one would expect to observe statistically significant relationships at the $p=0.05$ level one in twenty times, so erroneous findings of significance are inevitable when testing a large number of relationships.)

Statistical significance says nothing about whether the difference between that group of patents and others in the sample is large or practically significant. To draw those conclusions, it is necessary to examine the magnitude of the coefficients.[96] In our regressions,

---

magnitude or statistical significance of coefficients for technologies or industries between the parsimonious models and ones with the added controls.

93. More formally, this is a test of the null hypothesis that none of the technology or industry variables have predictive power.

94. 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 Article.

95. *See* Daniel L. Rubinfeld, *Reference Guide on Multiple Regression*, *in* FED. JUDICIAL CTR., *supra* note 62, at 303, 320.

96. 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 INST. FOR DIG. RESEARCH & EDUC., http://www.ats.ucla.edu/stat/stata/output/stata_ologit_output.htm [http://perma.cc/B34V-9CXY].

positive coefficients indicate that patents in that category were more likely to survive validity challenge than the unreported "comparison dummy"—which, for technology variables, means 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 4, 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 4. Ordered Logit Five-Level Outcomes by 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
	(0.270)	(0.0195)	(0.646)	(0.513)	(0.512)	(0.957)
Electrical	-0.0559	0.864*	1.221***	1.217**	-0.0525	-0.180
	(0.856)	(0.0873)	(0.000990)	(0.0416)	(0.874)	(0.820)
Chemistry	-0.0850	0.616	0.0934	0.212	-0.0337	-0.284
	(0.816)	(0.196)	(0.827)	(0.710)	(0.937)	(0.710)
Biotechnology	-0.141	0.556	0.0386	0.182	0.382	0.125
	(0.741)	(0.293)	(0.938)	(0.765)	(0.506)	(0.882)
Software (BusMeth)	-0.246	0.475	-0.842	-0.727	-0.138	-0.407
	(0.709)	(0.554)	(0.183)	(0.280)	(0.787)	(0.621)
Software (Not BusMeth)	-1.002***	-0.469	-0.269	0.0677	0.326	-0.0290
	(0.00411)	(0.396)	(0.457)	(0.910)	(0.418)	(0.970)
MPF Claim Element					-1.659***	-1.610***
					(7.8e-09)	(5.5e-09)
Reissue Patent	-0.309	-0.260	0.908	0.926	0.376	0.378
	(0.516)	(0.591)	(0.281)	(0.159)	(0.764)	(0.747)
Declaratory Judgment	0.110	0.137	0.318	0.196	-0.275	-0.283
	(0.682)	(0.591)	(0.457)	(0.623)	(0.300)	(0.297)
District Court Decision	0.662***	0.647***	0.101	0.0711	0.475**	0.483**
	(0.00494)	(0.00445)	(0.682)	(0.774)	(0.0196)	(0.0220)
Foreign Origin	1.041	1.000	0.0489	0.281	1.460	1.443
	(0.153)	(0.170)	(0.906)	(0.477)	(0.358)	(0.501)
Foreign Priority	-0.441	-0.367	0.467	0.176	-1.872	-1.831
	(0.583)	(0.640)	(0.338)	(0.716)	(0.239)	(0.395)
Post-*Markman*	-0.286	-0.278	0.134	0.176	0.660***	0.686***
	(0.262)	(0.259)	(0.654)	(0.567)	(0.00596)	(0.00457)
E.D. Tex.	-0.688	-0.679	-0.394	-0.0847	-0.147	-0.0820
	(0.213)	(0.216)	(0.527)	(0.894)	(0.683)	(0.806)
N.D. Cal.	-0.328	-0.344	-0.208	-0.281	0.411	0.398
	(0.248)	(0.213)	(0.546)	(0.417)	(0.202)	(0.215)
D. Del.	-0.160	-0.189	0.376	0.309	-0.175	-0.168
	(0.540)	(0.492)	(0.209)	(0.292)	(0.452)	(0.476)
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. More positive coefficients mean patents were more likely to be held not invalid.

Confirming the descriptive results we observed, patents on inventions in the primary mechanical-technology area performed significantly better than other areas in withstanding enablement

challenges in reported decisions ($p<0.05$), although primary-plus-secondary technology areas combined revealed no such advantage over other combined fields.

Again in agreement with the descriptive results, electrical patents had 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 ($p<0.00$l). Patents in the primary electrical-technology field, but not primary-plus-secondary, also performed better than those in other primary technology areas on enablement, but only at a $p<0.10$ level.[97]

Interestingly, we found no significant differences for either the chemistry or biotechnology areas on any of the disclosure or definiteness requirements. Surprisingly, the same was true for business-methods software patents, but patents on more traditional software inventions that were not business methods showed highly significant weakness on enablement, at least when primary and secondary technology areas were combined ($p<0.01$). 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.

As controls on the regression results for outcomes on the three § 112 issues by technology, we included the following variables:[98]

a. Whether the claim element at issue was in means-plus-function (MPF) format. Such format is 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

97. When data contain high levels 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.

98. We could have controlled for a number of other potential influences, such as number of citations received by the patents, numbers of prior-art references in the patents, ages of the time of litigation filing, and others. Given the size of our dataset, we were limited in how many variables we could test in a regression model. Previous research by one of us revealed that patent characteristics, such as numbers of citations received by patents in the dataset and total numbers of references to the prior art, had little discernible influence on specific litigation outcomes. Patent and litigation characteristics also did little to explain very specific litigation outcomes; that is, the "pseudo-R-squareds" of those regression models (reflecting the explanatory power of all of the independent variables combined on specific litigation outcomes) were very small. *See* Allison et al., *Realities of Modern Patent Litigation*, *supra* note 9, at 1799–1800. The pseudo-R-squareds for the ordered logit models in the present Article are also small, confirming that it is very difficult to explain or predict litigation outcomes at a highly specific level because of many influences on those outcomes that are undiscoverable or unmeasurable.

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.[99] If a litigant argues that a disputed claim term is in MPF format, the district court must first determine whether this is true—does the claim element identify only an unspecified means for performing a stated function? By definition, an MPF claim element contains no structure or steps for accomplishing the specified function. If a claim element is in MPF format, 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 is 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. This requirement 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).[100] We thus include this variable as a control, but only in the ordered logit models for the claim-definiteness issue.[101] The negative and very highly significant coefficients for both primary and primary-plus-secondary technology field comparisons reveal that a claim with an MPF element was far more likely to succumb to an indefiniteness challenge ($p<0.001$). One might think that this result is driven by recent software-patent cases following the Federal Circuit's 2008 decision in *Aristrocrat*, which embraced the use of indefiniteness to invalidate overbroad MPF software claims.[102] However, we reran these regressions with all software patents removed from the dataset, and again with an additional restriction to pre-2008 decisions, and in each case we found

99. 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.").

100. *Id.* § 112(b); *see* Robert Bosch, LLC v. Snap-On Inc., 769 F.3d 1094, 1097 (Fed. Cir. 2014).

101. 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 53, at 949–64. The subject is, of course, quite beyond the scope of this Article.

102. Aristocrat Techs. Austl. Pty Ltd. v. Int'l Game Tech., 521 F.3d 1328, 1338 (Fed. Cir. 2008).

the same negative and highly significant coefficients on the MPF variable. We thus think this is not an *Aristocrat*-specific result.

b. Whether the patent was a reissue. Because the granting 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 later litigation. We thus identified all reissue patents in our dataset, 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.

c. Whether the case was initiated as a declaratory-judgment action. Prior research by one of us revealed that accused infringers fare significantly better on several issues in patent litigation when they initiate 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.[103] 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 the absence of an effect—just that we cannot statistically demonstrate such an effect with this dataset. The prior study and the present one had fundamentally different goals, datasets, outcomes studied, and coding schemes.[104] Thus, whether "who goes first" makes a real difference in outcomes remains a viable question for further research.

d. Whether the last decision was rendered by a district court. Identifying those cases in which the last decision was made by a district court gives an opportunity to examine whether district courts

103. Allison et al., *Realities of Modern Patent Litigation*, *supra* note 9, at 1798 (finding these results after studying specific litigation outcomes using a dataset of 949 patent-case pairs for cases filed during 2008 and 2009 resulting in a merits outcome by the end of 2013).

104. The prior study used a database including only cases filed in 2008 and 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 different manner. *See id.* at 1772–76; *see also supra* note 15.

as a group or the Court of Appeals for the Federal Circuit display noticeably different tendencies when deciding disclosure and definiteness issues. Some have asserted 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.[105] For the decisions in our dataset, however, we found the reverse to be true for enablement and definiteness. Our regression results show that, while taking into account the effects of technologies and the other control variables described here, district courts as a group were 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 significant level ($p<0.05$). These *p*-values were for either primary technology fields alone or primary-plus-secondary technology areas combined. As discussed further in Part IV, this result might be attributable to selection effects, but we think the question of district court versus Federal Circuit tendencies deserves a closer empirical look.

e. Whether the patented invention originated outside the United States. We included this variable because recent research has revealed that foreign-origin patents significantly outperformed their U.S.-origin counterparts in American patent litigation.[106] In the present study, however, we found no significant effects of foreign origin on any of the § 112 outcomes in any technology field. Again, the two studies are very different in several fundamental respects.[107]

f. Whether the patent had a non-U.S. ("foreign") priority filing. Our goal in coding for whether the application for a patent in our dataset was originally filed outside the United States 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 statistically significant effect on any of the three § 112 outcomes.

---

105. *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); *see also* Kimberly A. Moore, Markman *Eight Years Later: Is Claim Construction More Predictable?*, 9 LEWIS & CLARK L. REV. 231, 240 & n.32 (2005) (noting that "[t]he Federal Circuit has long been criticized as a pro-patentee forum" and citing many references).

106. Allison et al., *Realities of Modern Patent Litigation*, *supra* note 9, at 1796–97.

107. *See supra* notes 103–04 and accompanying text.

g. Whether the decision occurred after the Federal Circuit's Markman *decision.* The 1995 Federal Circuit decision in *Markman v. Westview Instruments*, affirmed the next year by the Supreme Court,[108] 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.[109] Claim construction is a prerequisite to all infringement and validity decisions, as the court must determine the exact contours of the patented invention before being able to decide or instruct a jury about either.[110] Among other things, *Markman* greatly increased the focus on the claims in a patent, which brought indefiniteness allegations by defendants to the fore in each case in which any reasonable basis for such an allegation exists. The *Markman* rule is also critical for enablement and written-description questions: it is these claims, as interpreted, that must be enabled by the specification and that must describe an invention clearly envisioned by the inventors in that specification. An eponymous *Markman* hearing takes place after at least some pretrial discovery in practically every patent-infringement case, the sole goal of which is construction of disputed claim terms based on evidence and arguments presented by the litigants.[111] 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 render definiteness decisions before trial only in response to summary-judgment motions.[112] For the cases in our dataset, we find that whether a decision occurred after the Federal Circuit's *Markman* decision does not affect outcomes on either enablement or written description, but shows a highly significant effect on five-level claim-definiteness outcomes. Patent claims were much more likely to have been found definite (not indefinite) in cases decided after *Markman* than before ($p<0.01$). This does not mean that courts lowered the definiteness standard post-*Markman*; rather, we suspect our result is driven by a large number of

108. Markman v. Westview Instruments, 517 U.S. 370 (1996).

109. *Id.* at 381–82.

110. *Id.*

111. *See supra* note 11.

112. *See, e.g.*, Waddington N. Am., Inc. v. Sabert Corp., No. 09–4883 (GEB), 2010 WL 4363137, at *2–3 (D.N.J. Oct. 27, 2010) (declining to resolve an indefiniteness argument at the claims-construction stage as the issue was "more appropriately tackled at summary judgment").

weak indefiniteness challenges made by defendants during *Markman* hearings.

h. The district in which the case was filed. Patent-law commentators have debated for some time whether the federal district in which a patent litigant files its lawsuit matters to the suit's outcome.[113] Prior research does reveal some differences across districts. For example, a recent study by one of us found that out of the thirteen busiest federal districts for patent cases, patent owners were significantly more likely 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.[114] 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.[115] 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, with all other districts combined serving as the comparison dummy for district comparisons. Because the three top districts in our dataset account for over 400 of the 1104 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. 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. Whether a case was filed in any of these three districts had no statistically significant effect on enablement, written-description, or claim-definiteness outcomes. Again, this does not demonstrate the absence of an effect; it only means that we could not isolate an effect using our dataset. And our study does not examine possible district effects on definitive wins in patent-infringement cases, but only on outcomes on the three § 112 issues.

113. *See generally, e.g.*, J. Jonas Anderson, *Court Competition for Patent Cases*, 163 U. PA. L. REV. 631 (2015) (arguing that courts such as the Eastern District of Texas have favored plaintiffs to attract new patent cases).

114. Allison et al., *Realities of Modern Patent Litigation*, *supra* note 9, 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*.

115. *Id*.

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 between districts.

An additional variable that might influence outcomes is *time*. We thus reran all of the regressions presented here and in the Appendices with a continuous-year variable in addition to the post-*Markman* variable.[116] If Westlaw's increasing case coverage over time had a systematic effect on our variables of interest, or if there were a key change in doctrine over time besides *Markman*, it should be reflected in the coefficient for this variable. The coefficient on our continuous-year variable was only statistically significant in the three-level indefiniteness regressions, when it was negative; in these regressions, the coefficient on the post-*Markman* variable was higher and more significant. Including the continuous-year variable did not change the significance of any other coefficients and had little effect on their magnitudes, including in the three-level indefiniteness models, giving us increased confidence that temporal effects do not skew our results.[117]

C. Outcomes by Industry

1. *Scores on Ordinal Scales*. Table 5 shows the same descriptive analyses of outcomes by industries as we showed for technologies in Tables 1 and 2. As previously noted, the industry categories are mutually exclusive and are not separated into primary and secondary areas, and we separated the pharmaceutical-industry category into two subgroups: one containing patents in ANDA-related litigation and the other with patents in litigation not catalyzed by a generic drugmaker's filing of an ANDA. Table 5 reports five-level and three-level N's, mean scores, and standard deviations for the three § 112 issues by industry.

116. We would have included dummy variables for every year if we had had sufficient degrees of freedom, but our population size did not allow for this.

117. Although there is a limit to how many tables we think are useful to include even in an Appendix, we are happy to share these results upon request. As noted previously, our dataset will be published at the same time as this Article for readers who wish to test different models. *See supra* note 8.

Table 5: 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	2.56	1.59	3.07	2.13	4.11	2.560
	Sd	1.16	0.84	1.34	0.86	1.60	0.80
Semiconductor	**N**	26	26	15	15	22	22
	mean	3.39	2.27	4.13	2.80	4.05	2.68
	Sd	1.02	0.72	0.74	0.41	1.36	0.72
Pharmaceutical (All)	**N**	49	49	24	24	60	60
	mean	3.43	2.31	2.92	2.00	4.08	2.57
	Sd	1.34	0.87	1.02	0.89	1.36	0.72
Pharmaceutical (ANDA)	**N**	30	30	12	12	27	27
	mean	3.60	2.40	3.50	2.59	4.70	2.89
	Sd	1.33	0.86	0.80	0.80	0.67	0.32
Pharmaceutical (Not ANDA)	**N**	19	19	12	12	33	33
	mean	3.16	2.16	2.33	1.50	3.57	2.30
	Sd	1.34	0.90	0.89	0.67	1.56	0.85
Biotechnology	**N**	22	22	20	20	16	16
	mean	3.46	2.36	3.05	2.10	4.88	3
	Sd	1.18	0.79	1.47	0.85	0.34	0
Medical Devices & Methods	**N**	73	73	61	61	74	74
	mean	3.56	2.41	3.12	2.18	4.10	2.61
	Sd	1.21	0.70	1.42	0.83	1.48	0.76
Communications	**N**	21	21	17	17	59	59
	mean	3.67	2.38	3.12	2.18	3.83	2.46
	Sd	1.24	0.81	1.62	0.95	1.72	0.88
Transportation (Incl. Auto)	**N**	14	14	14	14	39	39
	mean	3.07	2.14	3.43	2.21	4.41	2.72
	Sd	1.54	0.86	1.40	0.70	1.37	0.69
Construction	**N**	16	16	9	9	28	28
	mean	3.75	2.50	3.67	2.56	4.25	2.68
	Sd	1.06	0.82	1.23	0.73	1.43	0.72
Energy	**N**	22	22	11	11	36	36
	mean	3.82	2.64	3.27	2.36	4.47	2.78
	sd	1.30	0.73	1.27	0.81	1.18	0.59
Consumer Goods & Services	**N**	37	37	29	29	82	82
	mean	3.97	2.51	3.90	2.55	4.20	2.62
	sd	1.14	0.65	1.21	0.69	1.46	0.75
Industrial Goods & Services	**N**	121	121	69	69	155	155
	mean	3.54	2.36	3.33	2.25	3.99	2.54
	sd	1.29	0.80	1.35	0.79	1.57	0.82

Across all categories, we again find higher average scores on claim definiteness than on the other two issues as one would expect, because these are the same patents challenged for indefiniteness as in the technology areas. But the differences between industries are interesting. Because we used 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 have larger standard errors than those in the six technology areas, so they should be viewed with caution. Still, a number of the differences between mean-outcome scores for industry categories are statistically significant.

Biotechnology-industry patents, which 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 4.88 was based on only sixteen observations and is thus 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 divide into those patents that were litigated as the result of ANDA filings by generic-drug manufacturers and those that were not. Patents in ANDA-related litigation survived contests over claim definiteness remarkably well, with a five-level score of 4.70, just below that experienced by patents from the biotechnology industry. This performance stands in stark contrast with that of pharmaceutical patents in non-ANDA litigation, which fared worse than any other industry grouping against assertions of indefiniteness. The definiteness chasm between patents in ANDA and non-ANDA pharmaceutical litigation may be caused by ANDA patents' being more likely to cover compositions.[118] These patents also are likely to have far more private economic value to their owners than many other kinds of patents, meaning that patentees will invest much more in fighting to preserve their validity.[119] Energy-, transportation-, and

118. *See supra* note 80.

119. Researchers have uncovered evidence that the average patent on pharmaceutical compositions has more value than the average patent in other industries, and that patent protection is more important in this field than in others. *See* Richard C. Levin, Alvin K.

construction-industry patents, in descending order, likewise scored higher than the all-industry mean of 4.21, while patents in the consumer-goods/services and computer/other-electronics industries were barely below the mean. Semiconductor- and industrial-goods/services-industry patents performed below the all-industry mean; communications-industry patents were 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 3.47 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 below at the bottom of the list.

The mean of the eleven industry means for the written-description requirement, at 3.36, was slightly below that for enablement. We find some of the same industries above and some of the same below the all-industry mean, we observed 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 scored well, as did ANDA-related pharmaceuticals, and those in the computers/other-electronics industry again performed relatively poorly. Other industry groups were scattered around the all-industry mean.

Klevorick, Richard R. Nelson & Sidney G. Winter, *Appropriating the Returns from Industrial Research and Development*, 1987 BROOKINGS PAPERS ON ECON. ACTIVITY 783, 796, 824; Edwin Mansfield, *Patents and Innovation: An Empirical Study*, 32 MGMT. SCI. 173, 174 (1986); 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 (Nat'l Bureau of Econ. Research, Working Paper No. 7552, 2000), http://www.nber.org/papers/w7552.pdf [http://perma.cc/D79H-Y5WQ]; *see also* Lisa Larrimore Ouellette, Note, *How Many Patents Does it Take to Make a Drug? Follow-On Pharmaceutical Patents and University Licensing*, 17 MICH. TELECOMM. & TECH. L. REV. 299, 303 (2010) ("Although [the latest of the above-referenced] surveys are over ten years old, the importance of patents to the pharmaceutical industry has not abated.").

In Table 6, we average the three mean scores for each industry to take the same broad look at overall § 112 performance by industry that we did by technology.

Table 6: Mean Five-Level Scores by Industry Across All § 112 Requirements

Industry	Mean 5-Level Score
Consumer Goods & Services	4.02
Pharmaceutical (ANDA)	3.94
Construction	3.89
Semiconductor	3.85
Energy	3.85
Biotechnology	3.79
Transportation (Incl. Auto)	3.64
Industrial Goods & Services	3.62
Medical Devices & Methods	3.59
Communications	3.54
Pharmaceutical (All)	3.48
Computer & Other Electronics	3.25
Pharmaceutical (Non-ANDA)	3.02
Mean	3.68

The mean score for all industries across all three § 112 requirements was 3.68; on our five-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 five-level scale; it may be possible to see how the presumption of validity for granted patents is applied in practice across different doctrines.[120]

Six industry categories score above the five-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. There is little separation between the first five industries below the all-

120. Under 35 U.S.C. § 282(a) (2012), 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, 2242 (2011).

industry mean on all § 112 issues: transportation/automotive, industrial goods/services, medical devices/methods, communications, and pharmaceutical (all). The five-level mean for the next industry, computer/other electronics, is substantially lower, and non-ANDA pharmaceutical resides at the bottom of the heap.

2. *Regression Results by Industries and Issues.* Table 7 shows results from the ordered logit regression models on industries. For the regressions shown here, we separated pharmaceutical-industry patents into ANDA and non-ANDA categories; regressions with the pharmaceutical group as a whole are in the Appendix. We used industrial/business goods and services (that is, goods and services for wholesale purposes that do not fall into a more specific industry category) as the industry-comparison dummy. Although results for the other industries are presented in juxtaposition with the comparison dummy, one can also compare the coefficient for each industry against those of other industries.

Table 7. Ordered Logit Five-Level Outcomes by Industry

	Enablement	**Written Description**	**Indefiniteness**
Computer & Other Electronics	-1.623***	-0.236	0.265
	(0.000205)	(0.596)	(0.424)
Semiconductor	-0.220	1.085**	0.0589
	(0.529)	(0.0343)	(0.893)
Pharma: ANDA	0.0905	0.155	0.722
	(0.832)	(0.720)	(0.531)
Pharma: Non-ANDA	-0.428	-1.214***	-0.682*
	(0.404)	(0.00189)	(0.0505)
Biotechnology	0.0277	-0.140	1.194
	(0.943)	(0.819)	(0.801)
Medical Devices & Methods	0.0212	-0.268	-0.0512
	(0.944)	(0.556)	(0.861)
Communications	0.125	-0.371	0.111
	(0.821)	(0.664)	(0.756)
Transportation (Incl. Auto)	-1.043	0.298	0.667
	(0.190)	(0.700)	(0.204)
Construction	0.0853	0.593	0.269
	(0.867)	(0.490)	(0.602)
Energy	0.702	-0.327	0.249
	(0.104)	(0.573)	(0.626)
Consumer Goods & Services	0.667	0.987**	0.175
	(0.138)	(0.0473)	(0.584)
MPF Claim Element			-1.611***
			(1.58e-08)
Reissue Patent	-0.192	0.340	0.364
	(0.696)	(0.616)	(0.759)
Declaratory Judgment	0.523*	0.344	-0.200
	(0.0955)	(0.409)	(0.463)
District Court Decision	0.614**	-0.0269	0.453**
	(0.0152)	(0.914)	(0.0382)
Foreign Origin	1.343*	0.414	1.487
	(0.0529)	(0.379)	(0.352)
Foreign Priority	-0.747	0.152	-1.778
	(0.328)	(0.776)	(0.267)
Post-*Markman*	-0.315	-0.547*	0.541**
	(0.223)	(0.0819)	(0.0222)
E.D. Tex.	-0.640	0.210	-0.0510
	(0.234)	(0.774)	(0.874)
N.D. Cal.	-0.316	-0.0288	0.374
	(0.274)	(0.941)	(0.253)
D. Del.	-0.136	0.432	-0.114
	(0.633)	(0.189)	(0.662)
N	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. More positive coefficients mean patents were more likely to be held not invalid.

Computer/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 had better average validity outcomes 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 had better validity outcomes 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 between industries. In both technologies and industries, we observed 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 in Table 7 as for the technology models in Table 4. Unsurprisingly, we found similar results. As in the technology regressions, a disputed-claim term being in MPF format decreased the odds of a favorable ruling on definiteness ($p<0.01$), district courts were more likely than the Federal Circuit to favor patent owners on enablement and definiteness ($p<0.05$), and post-*Markman* decisions on definiteness were more favorable to the patentee ($p<0.05$). The industry-specific regression model also found that patents in post-*Markman* cases did slightly worse ($p<0.10$) on written description. Whether a case was brought 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. Patents on foreign-origin inventions fared slightly better on enablement than did their American-origin counterparts ($p<0.10$). As with our technology logit models, we found no district effects. The same test with a continuous-year variable, that was described

previously for the technology models, was repeated for the industry models, with the same results.[121]

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

Our descriptive measures show that among technology groups, patents on inventions in the older electrical, mechanical, and chemistry fields were the most likely to be upheld against § 112 challenges in reported decisions. Software-business-method patents fared better than most observers probably would have supposed, but software patents covering inventions that are not business methods performed poorly enough 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 regression 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 scoring better on enablement. At the other end of the technology spectrum, software patents other than business methods fared poorly on enablement.[122]

Across industry categories, pharmaceutical-industry patents in ANDA-related litigation performed very well on our descriptive measures, but non-ANDA pharmaceutical patents had weak outcomes. Patents in the computer-and-other-electronics industry also did not fare well 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 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

121. *See supra* text accompanying notes 116–17.

122. Technical (not business-method) software patents performing poorly on enablement means either that courts were applying this section 112 requirement to these patents with relative rigor or that the technical software patents that reached a decision on enablement tended to be less well enabled than other patents at that stage of litigation.

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 industry categories were much more likely to fall on indefiniteness grounds when the challenged claim element was drafted in means-plus-function format, and were more likely to survive indefiniteness challenges in post-*Markman* decisions. We also found that 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 appear to 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 is thus decidedly mixed. And the following Part sounds some additional notes of caution in interpreting these results.

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 nonlitigated 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. Patent applicants may draft these patents differently in the first place. And our dataset is not representative of all patents: 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 percent

resulted in a merits decision.[123] Differences in litigation outcomes (that is, 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, when 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.[124] 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.[125] An extensive literature has documented the ways in which actual litigation deviates from the Priest-Klein assumptions,[126] including in the patent context.[127]

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 in another paper, there are many plausible technology-specific selection stories.[128] For example, pharmaceutical patent holders may have

123. Allison et al., *Realities of Modern Patent Litigation*, *supra* note 9, at 1780.

124. George L. Priest & Benjamin Klein, *The Selection of Disputes for Litigation*, 13 J. LEGAL STUD. 1, 4–5, 16–17 (1984).

125. *Id.* at 26.

126. *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 . . . .").

127. *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.").

128. Allison et al., *Divided Patent System*, *supra* note 9, at 1125–40.

stronger incentives than other patent owners to settle their cases.[129] On the other hand, because each individual pharmaceutical patent is typically more valuable than the average patent in other industries,[130] patent owners may be more willing to undertake the high costs of patent litigation in the pharmaceutical industry or take more care in drafting patents in the first place.[131] It is also possible that judges might be less willing (perhaps subconsciously) to invalidate these patents because of the significant investment required for producing new drugs. Nonpracticing entities (NPEs), which are particularly

---

129. *See* C. Scott Hemphill & Mark A. Lemley, *Earning Exclusivity: Generic Drug Incentives and the Hatch-Waxman Act*, 77 ANTITRUST L.J. 947, 948–49 (2011) (discussing the strong incentives of brand-name pharmaceutical companies to settle patent lawsuits).

130. *See* Ouellette, *supra* note 119, 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).

131. Possible selection effects on outcomes in ANDA-triggered pharmaceutical patent litigation are especially thorny, as summarized by the following excerpt from a prior study by one of us with Mark Lemley and David Schwartz:

> One selection story relates to the particulars of pharmaceutical-industry patent litigation. Generic-drug litigation occurs under the [1984] Hatch-Waxman Act, which separates these cases from garden-variety patent infringement litigation. Before filing the lawsuit, the branded-drug patentee has an FDA-granted monopoly. The status quo is no competition, and there can be no direct infringement until the FDA approves the generic drug's application, which in turn usually cannot happen until pending litigation is resolved.
>
> Pharmaceutical-industry patent cases also routinely involve drugs with large market shares, prices, or profits. The costs of litigation to the branded manufacturer typically are small relative to the drug's profits. These facts might push the branded companies to refuse to settle strong cases because they will win anyway. In fact, however, brand owners may have even stronger incentives than other patent owners to settle their cases. Because pharmaceutical patent owners will face no generic competition unless they lose a patent case, they have often pay their generic challengers to drop their challenges, in effect splitting the monopoly profits with the generic rather than taking the risk that the patent will be held invalid. Thus, unlike patentees in the other industries, branded-drug companies (the patent owners) sometimes offer to pay a generic, in an arrangement commonly known as a "reverse payment." Such reverse-payment settlements were extremely common during the period of our dataset, though recent antitrust scrutiny may make them less likely in the future.
>
> These different incentives make the direct comparison to "regular" patent litigation difficult. That said, it is not obvious that the selection story explains our results. The willingness of brand owners to use reverse payments to settle disputes might suggest that only particularly weak invalidity challenges (that is, valid patents) go to judgment, because only in those cases is the patentee willing to take a chance on a judicial outcome. But it could suggest the opposite—that generics lured by the promise of a reverse payment will refuse to settle only their strongest challenges. The abbreviated new drug application (ANDA) process itself may encourage weak drug challenges, with little downside risk to the generic beyond paying its own lawyers. The most we can say about the selection story as an explanation for our pharmaceutical-industry results is that patent litigation in the pharmaceutical industry involves a variety of incentives that are distinct from other patent litigation, which may result in a different mix of patents surviving until adjudication.

Allison et al., *Divided Patent System*, *supra* note 9, at 1128–29 (citations omitted).

prevalent in the software-technology area and in the broader computer industry, may be more willing to assert weaker patents and more interested in settling lawsuits.[132] In sum, it is easy to generate plausible causal narratives,[133] but hard to determine which directions these effects will cut in practice.

Selection effects are particularly important to consider when evaluating the implications of our discovery that district courts decisions in our dataset were less likely to find patents invalid for enablement and indefiniteness than appellate court decisions. District court decisions invalidating patents may be more likely to be appealed than decisions upholding validity, which may explain part of our result. We also suspect that district court decisions are less likely to be reported in Westlaw than circuit court ones, and that decisions invalidating patents are probably more likely to be reported than those finding patents not invalid. If so, these database coverage issues would cut in the opposite direction as our result. This effect seems unlikely to be outweighed by the difference in appeal rate, but we cannot be sure. Thus, although we can confidently assert that patents were more likely to be upheld in reported district court § 112 decisions than in appellate decisions, this does not necessarily mean that district court judges are more pro-patent than Federal Circuit judges. We think the sources of this effect warrant further study.

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, we have 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."[134] Indeed, Daniel Klerman and Yoon-Ho Alex Lee recently demonstrated that "under the three standard settlement

132. *See* John R. Allison, Mark A. Lemley & Joshua Walker, *Patent Quality and Settlement Among Repeat Patent Litigants*, 99 GEO. L.J. 677, 689, 693–94 (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).

133. *See* DANIEL KAHNEMAN, THINKING, FAST AND SLOW 199–202 (2011) (describing this phenomenon).

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

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."[135] 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.[136] 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 fact issues remain (such as denials of summary judgment) captures a somewhat richer picture of § 112 adjudication than studies that have focused only on merits rulings that adjudicate an issue.[137] Although many cases will be resolved before the court has any opportunity to opine on § 112 issues, our data at least include meaningful numbers of cases that are later settled.[138]

From a methodological standpoint, we believe in the substantial value of empirically and doctrinally examining what courts do in patent law, both on specific issues and on broader policy questions and trends. When considering our specific empirical analyses, it is important to simultaneously keep the broader view in mind. Our findings on disclosure and definiteness holdings over a thirty-year period do not, for instance, say anything about overall patent quality or economic value. They also have little to say about overall patent litigation outcomes. John Allison, Mark Lemley, and David Schwartz recently found that the overall win rate for patentees on both infringement and validity was only 26 percent, a rate consistent with that found previously by others.[139] As Mark Lemley has observed, patent owners must overcome many distinct hurdles to win, and only

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

136. Jason Rantanen, Why Priest-Klein Cannot Apply to Individual Issues in Patent Cases 3 (Mar. 21, 2013) (unpublished manuscript), http://ssrn.com/abstract=2132810 [http://perma.cc/MT7A-8SF9].

137. Allison et al., *Realities of Modern Patent Litigation*, *supra* note 9, 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.").

138. 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 57, at 368 (discussing the application of Priest-Klein in the differing contexts of granted patents and applications).

139. Allison et al., *Realities of Modern Patent Litigation*, *supra* note 9, at 1787.

have to fail on one of them to lose the case.[140] And to lose on a single invalidity assertion means to lose the patent itself. 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,[141] and if the likelihood of the patent owner's success on each issue is 80 percent (giving the challenger a 20-percent chance of proving invalidity by clear and convincing evidence on each issue), the patent owner stands only a 41-percent chance of winning on all of these validity issues, which translates to a 59-percent chance of losing its patent for good. A patent owner must also prove infringement to win a case, and if it has, say, a 50-percent chance of doing so, it has only a 20.5-percent chance of prevailing overall.

CONCLUSION

Our results show that over the past thirty years, judicial outcomes in reported cases on patent disclosure and claim definiteness have varied to some degree among technologies and industries. After other influences are factored in, however, 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. We also discovered several factors other than technology and industry that were significantly correlated with different outcomes. 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. Claims drafted in means-plus-function format had significantly worse outcomes on indefiniteness. And post-*Markman* decisions were significantly more likely to uphold patents against indefiniteness challenges.

As we have explained, one must be cautious in generalizing from our results to make broader claims about patent-litigation outcomes in general or about nonlitigated patents. Instances in which we found no statistically significant difference between outcomes for two groups of patents in our data do not disprove claims that courts have applied different legal standards to those two groups—the differences

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

141. We say that three invalidity challenges is not an unrealistic number based on our having read thousands of patent cases over a period of decades.

might have been simply washed out by selection effects. But it does show that courts have not reached dramatically different *outcomes* in the two groups. Our dataset also serves to identify the full population of reported § 112 decisions, which will facilitate more contextual analysis of particular doctrines with confidence that the results are not based on mere anecdotes. We thus believe that this project will enrich future discussions of § 112 reform.

APPENDIX

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

	(1)	(2)	(3)	(4)
	3-level	**3-level**	**5-level**	**5-level**
Mechanical	0.442	0.424	0.340	0.333
	(0.212)	(0.237)	(0.256)	(0.311)
Electrical	0.0765	0.112	-0.101	-0.103
	(0.787)	(0.710)	(0.707)	(0.736)
Chemistry	0.0324	0.0575	-0.111	-0.126
	(0.931)	(0.885)	(0.736)	(0.719)
Biotechnology	-0.112	0.111	-0.330	-0.182
	(0.806)	(0.817)	(0.415)	(0.670)
Software	-1.044***	-1.035***	-0.902***	-0.915***
	(0.00161)	(0.00156)	(0.00600)	(0.00899)
Software (BusMeth)				
Software (Not BusMeth)				
Reissue Patent		-0.211		-0.265
		(0.756)		(0.555)
Declaratory Judgment		-0.0527		0.0731
		(0.875)		(0.789)
District Court Decision		0.653**		0.672***
		(0.0157)		(0.00272)
Foreign Origin		1.063		0.988
		(0.541)		(0.159)
Foreign Priority		-0.379		-0.412
		(0.830)		(0.595)
Post-*Markman*		-0.602*		-0.275
		(0.0861)		(0.272)
E.D. Tex.		-0.195		-0.562
		(0.900)		(0.299)
N.D. Cal.		-0.470*		-0.348
		(0.0690)		(0.219)
D. Del.		-0.171		-0.120
		(0.534)		(0.652)
F-test for Joint Tech. Effects	30.56***	27.49***	22.42***	16.62***
	(1.14e-05)	(4.58e-05)	(0.00044)	(0.00528)
N	433	433	433	433

	(5)	(6)	(7)	(8)
	3-level	**3-level**	**5-level**	**5-level**
Mechanical	0.490	0.479	0.365	0.368
	(0.177)	(0.207)	(0.233)	(0.270)
Electrical	0.132	0.183	-0.0709	-0.0559
	(0.669)	(0.567)	(0.798)	(0.856)
Chemistry	0.0785	0.118	-0.0869	-0.0850
	(0.836)	(0.772)	(0.789)	(0.816)
Biotechnology	-0.0626	0.173	-0.305	-0.141
	(0.891)	(0.722)	(0.437)	(0.741)
Software				
Software (BusMeth)	-0.504	-0.392	-0.378	-0.246
	(0.473)	(0.518)	(0.540)	(0.709)
Software (Not BusMeth)	-1.121***	-1.116***	-0.979***	-1.002***
	(0.000705)	(0.00102)	(0.00291)	(0.00411)
Reissue Patent		-0.251		-0.309
		(0.798)		(0.516)
Declaratory Judgment		-0.00931		0.110
		(0.978)		(0.682)
District Court Decision		0.640**		0.662***
		(0.0217)		(0.00494)
Foreign Origin		1.120		1.041
		(0.517)		(0.153)
Foreign Priority		-0.397		-0.441
		(0.820)		(0.583)
Post-*Markman*		-0.611*		-0.286
		(0.0982)		(0.262)
E.D. Tex.		-0.371		-0.688
		(0.753)		(0.213)
N.D. Cal.		-0.449*		-0.328
		(0.0824)		(0.248)
D. Del.		-0.218		-0.160
		(0.426)		(0.540)
F-test for Joint Tech. Effects	29.97***	26.43***	22.36***	19.78***
	(3.98e-05)	(0.00019)	(0.00104)	(0.00303)
N	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)
	3-level	**3-level**	**5-level**	**5-level**
Mechanical	0.217	0.228	0.206	0.251
	(0.570)	(0.583)	(0.510)	(0.496)
Electrical	1.456***	1.520***	1.097***	1.300***
	(0.000355)	(0.000831)	(0.000123)	(0.00022)
Chemistry	0.378	0.283	0.265	0.175
	(0.442)	(0.596)	(0.499)	(0.673)
Biotechnology	-0.0800	0.108	-0.0382	0.117
	(0.880)	(0.840)	(0.931)	(0.807)
Software	-0.509	-0.370	-0.454	-0.374
	(0.180)	(0.364)	(0.152)	(0.286)
Software (BusMeth)				
Software (Not BusMeth)				
Reissue Patent		0.791		0.900
		(0.800)		(0.312)
Declaratory Judgment		0.378		0.363
		(0.405)		(0.390)
District Court Decision		-0.00752		0.119
		(0.979)		(0.628)
Foreign Origin		0.381		0.0723
		(0.615)		(0.854)
Foreign Priority		0.230		0.482
		(0.773)		(0.292)
Post-*Markman*		-0.549		0.111
		(0.481)		(0.713)
E.D. Tex.		0.0746		-0.489
		(0.948)		(0.425)
N.D. Cal.		-0.0308		-0.166
		(0.936)		(0.649)
D. Del.		0.442		0.337
		(0.224)		(0.261)
F-test for Joint Tech. Effects	23.55***	15.48***	25.34***	21.43***
	(0.000265)	(0.00850)	(0.000120)	(0.00067)
N	299	299	299	299

	(5)	(6)	(7)	(8)
	3-level	**3-level**	**5-level**	**5-level**
Mechanical	0.151	0.144	0.148	0.176
	(0.704)	(0.756)	(0.637)	(0.646)
Electrical	1.370***	1.412***	1.037***	1.221***
	(0.00122)	(0.00147)	(0.000273)	(0.000990)
Chemistry	0.316	0.186	0.210	0.0934
	(0.524)	(0.748)	(0.600)	(0.827)
Biotechnology	-0.149	0.0140	-0.0981	0.0386
	(0.779)	(0.981)	(0.827)	(0.938)
Software				
Software (BusMeth)	-1.048*	-0.972	-0.926*	-0.842
	(0.0528)	(0.136)	(0.0688)	(0.183)
Software (Not BusMeth)	-0.348	-0.218	-0.322	-0.269
	(0.368)	(0.597)	(0.316)	(0.457)
Reissue Patent		0.799		0.908
		(0.819)		(0.281)
Declaratory Judgment		0.319		0.318
		(0.493)		(0.457)
District Court Decision		-0.0371		0.101
		(0.897)		(0.682)
Foreign Origin		0.328		0.0489
		(0.737)		(0.906)
Foreign Priority		0.229		0.467
		(0.821)		(0.338)
Post-*Markman*		-0.532		0.134
		(0.481)		(0.654)
E.D. Tex.		0.239		-0.394
		(0.832)		(0.527)
N.D. Cal.		-0.0731		-0.208
		(0.844)		(0.546)
D. Del.		0.525		0.376
		(0.172)		(0.209)
F-test for Joint Tech. Effects	24.54***	20.19***	26.90***	21.41***
	(0.000416)	(0.00256)	(0.000151)	(0.00155)
N	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)
	3-level	**3-level**	**5-level**	**5-level**
Mechanical	0.233	0.185	0.347	0.294
	(0.508)	(0.664)	(0.273)	(0.461)
Electrical	-0.151	-0.133	-0.0535	0.00597
	(0.600)	(0.688)	(0.840)	(0.985)
Chemistry	-0.225	-0.339	0.0532	0.00375
	(0.572)	(0.450)	(0.875)	(0.993)
Biotechnology	0.193	0.339	0.382	0.427
	(0.888)	(0.803)	(0.450)	(0.481)
Software	-0.515	-0.165	0.00272	0.242
	(0.120)	(0.690)	(0.993)	(0.535)
Software (BusMeth)				
Software (Not BusMeth)				
MPF Claim Element		-1.570***		-1.673***
		(7.08e-08)		(1.81e-09)
Reissue Patent		0.758		0.361
		(0.865)		(0.786)
Declaratory Judgment		-0.187		-0.261
		(0.578)		(0.349)
District Court Decision		0.529**		0.476**
		(0.0268)		(0.0247)
Foreign Origin		1.125		1.429
		(0.560)		(0.465)
Foreign Priority		-1.459		-1.800
		(0.453)		(0.359)
Post-*Markman*		0.212		0.645***
		(0.562)		(0.00446)
E.D. Tex.		-0.269		-0.105
		(0.389)		(0.755)
N.D. Cal.		0.321		0.386
		(0.363)		(0.208)
D. Del.		0.163		-0.199
		(0.601)		(0.413)
F-test for Joint Tech. Effects	11.37**	4.119	4.328	2.245
	(0.045)	(0.532)	(0.503)	(0.814)
N	673	673	673	673

	(5)	(6)	(7)	(8)
	3-level	**3-level**	**5-level**	**5-level**
Mechanical	0.168	0.120	0.304	0.259
	(0.641)	(0.784)	(0.309)	(0.512)
Electrical	-0.243	-0.229	-0.113	-0.0525
	(0.412)	(0.503)	(0.674)	(0.874)
Chemistry	-0.293	-0.407	0.00833	-0.0337
	(0.461)	(0.392)	(0.980)	(0.937)
Biotechnology	0.122	0.261	0.336	0.382
	(0.923)	(0.850)	(0.618)	(0.506)
Software				
Software (BusMeth)	-0.991**	-0.694	-0.365	-0.138
	(0.0287)	(0.180)	(0.382)	(0.787)
Software (Not BusMeth)	-0.430	-0.0505	0.0701	0.326
	(0.203)	(0.909)	(0.808)	(0.418)
MPF Claim Element		-1.550***		-1.659***
		(1.32e-07)		(7.80e-09)
Reissue Patent		0.774		0.376
		(0.868)		(0.764)
Declaratory Judgment		-0.219		-0.275
		(0.515)		(0.300)
District Court Decision		0.525**		0.475**
		(0.0273)		(0.0196)
Foreign Origin		1.170		1.460
		(0.556)		(0.358)
Foreign Priority		-1.579		-1.872
		(0.429)		(0.239)
Post-*Markman*		0.233		0.660***
		(0.534)		(0.00596)
E.D. Tex.		-0.339		-0.147
		(0.316)		(0.683)
N.D. Cal.		0.351		0.411
		(0.354)		(0.202)
D. Del.		0.219		-0.175
		(0.474)		(0.452)
F-test for Joint Tech. Effects	14.77**	6.666	5.859	3.470
	(0.0221)	(0.353)	(0.439)	(0.748)
N	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)
	3-level	**3-level**	**5-level**	**5-level**
Mechanical	0.994**	1.007**	1.070**	1.095**
	(0.0268)	(0.0209)	(0.0194)	(0.0187)
Electrical	0.750	0.874*	0.773	0.859*
	(0.153)	(0.0777)	(0.136)	(0.0793)
Chemistry	0.520	0.574	0.579	0.602
	(0.262)	(0.185)	(0.214)	(0.191)
Biotechnology	0.389	0.653	0.352	0.548
	(0.460)	(0.208)	(0.505)	(0.277)
Software	-0.614	-0.528	-0.335	-0.297
	(0.192)	(0.226)	(0.479)	(0.542)
Software (BusMeth)				
Software (Not BusMeth)				
Reissue Patent		-0.127		-0.208
		(0.874)		(0.653)
Declaratory Judgment		-0.0524		0.0884
		(0.880)		(0.735)
District Court Decision		0.615**		0.658***
		(0.0220)		(0.00400)
Foreign Origin		1.073		0.923
		(0.513)		(0.175)
Foreign Priority		-0.364		-0.312
		(0.828)		(0.678)
Post-*Markman*		-0.561		-0.266
		(0.106)		(0.255)
E.D. Tex.		-0.170		-0.541
		(0.905)		(0.294)
N.D. Cal.		-0.481*		-0.378
		(0.0826)		(0.166)
D. Del.		-0.176		-0.144
		(0.518)		(0.592)
F-test for Joint Tech. Effects	38.82***	28.70***	30.03***	25.80***
	(2.6e-07)	(2.7e-05)	(1.5e-05)	(9.8e-05)
N	433	433	433	433

	(5)	(6)	(7)	(8)
	3-level	**3-level**	**5-level**	**5-level**
Mechanical	0.996**	1.008**	1.072**	1.099**
	(0.0287)	(0.0254)	(0.0167)	(0.0195)
Electrical	0.751	0.877*	0.774	0.864*
	(0.151)	(0.0761)	(0.116)	(0.0873)
Chemistry	0.521	0.585	0.581	0.616
	(0.253)	(0.195)	(0.195)	(0.196)
Biotechnology	0.390	0.657	0.353	0.556
	(0.462)	(0.218)	(0.475)	(0.293)
Software				
Software (BusMeth)	-0.0321	0.123	0.297	0.475
	(0.955)	(0.848)	(0.663)	(0.554)
Software (Not BusMeth)	-0.765	-0.765	-0.681	-0.469
	(0.101)	(0.169)	(0.332)	(0.396)
Reissue Patent		-0.166		-0.260
		(0.866)		(0.591)
Declaratory Judgment		-0.00197		0.137
		(0.995)		(0.591)
District Court Decision		0.599**		0.647***
		(0.0285)		(0.00445)
Foreign Origin		1.145		1.000
		(0.529)		(0.170)
Foreign Priority		-0.403		-0.367
		(0.826)		(0.640)
Post-*Markman*		-0.567		-0.278
		(0.117)		(0.259)
E.D. Tex.		-0.353		-0.679
		(0.827)		(0.216)
N.D. Cal.		-0.445		-0.344
		(0.113)		(0.213)
D. Del.		-0.223		-0.189
		(0.430)		(0.492)
F-test for Joint Tech. Effects	34.86***	30.42***	29.83***	28.68***
	(4.6e-06)	(3.3e-05)	(4.2e-05)	(7.00e-05)
N	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)
	3-level	**3-level**	**5-level**	**5-level**
Mechanical	0.561	0.465	0.405	0.371
	(0.608)	(0.623)	(0.394)	(0.501)
Electrical	1.325	1.293	1.080**	1.205**
	(0.258)	(0.206)	(0.0308)	(0.0397)
Chemistry	0.583	0.385	0.375	0.231
	(0.598)	(0.697)	(0.441)	(0.685)
Biotechnology	0.126	0.223	0.0776	0.183
	(0.911)	(0.824)	(0.890)	(0.753)
Software	-0.167	-0.127	-0.231	-0.192
	(0.879)	(0.896)	(0.628)	(0.728)
Software (BusMeth)				
Software (Not BusMeth)				
Reissue Patent		0.758		0.898
		(0.809)		(0.242)
Declaratory Judgment		0.264		0.255
		(0.554)		(0.528)
District Court Decision		-0.00692		0.0948
		(0.981)		(0.694)
Foreign Origin		0.564		0.341
		(0.411)		(0.388)
Foreign Priority		0.00163		0.151
		(0.998)		(0.744)
Post-*Markman*		-0.546		0.148
		(0.536)		(0.645)
E.D. Tex.		0.281		-0.201
		(0.822)		(0.720)
N.D. Cal.		-0.0408		-0.213
		(0.912)		(0.559)
D. Del.		0.411		0.256
		(0.268)		(0.374)
F-test for Joint Tech. Effects	15.56***	9.558*	14.07**	11.33**
	(0.008)	(0.0888)	(0.0152)	(0.0453)
N	299	299	299	299

	(5)	(6)	(7)	(8)
	3-level	**3-level**	**5-level**	**5-level**
Mechanical	0.563	0.453	0.409	0.370
	(0.571)	(0.661)	(0.390)	(0.513)
Electrical	1.330	1.290	1.088**	1.217**
	(0.245)	(0.247)	(0.0335)	(0.0416)
Chemistry	0.586	0.348	0.380	0.212
	(0.562)	(0.747)	(0.442)	(0.710)
Biotechnology	0.127	0.207	0.0792	0.182
	(0.901)	(0.849)	(0.884)	(0.765)
Software				
Software (BusMeth)	-0.744	-0.802	-0.712	-0.727
	(0.470)	(0.472)	(0.211)	(0.280)
Software (Not BusMeth)	0.120	0.175	0.0103	0.0677
	(0.905)	(0.866)	(0.984)	(0.910)
Reissue Patent		0.800		0.926
		(0.800)		(0.159)
Declaratory Judgment		0.193		0.196
		(0.659)		(0.623)
District Court Decision		-0.0451		0.0711
		(0.884)		(0.774)
Foreign Origin		0.477		0.281
		(0.523)		(0.477)
Foreign Priority		0.0375		0.176
		(0.962)		(0.716)
Post-*Markman*		-0.525		0.176
		(0.580)		(0.567)
E.D. Tex.		0.477		-0.0847
		(0.724)		(0.894)
N.D. Cal.		-0.105		-0.281
		(0.772)		(0.417)
D. Del.		0.510		0.309
		(0.150)		(0.292)
F-test for Joint Tech. Effects	16.94***	13.18**	17.36***	14.12**
	(0.0095)	(0.040)	(0.0081)	(0.0283)
N	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)
	3-level	**3-level**	**5-level**	**5-level**
Mechanical	0.232	0.122	0.131	0.0372
	(0.895)	(0.943)	(0.875)	(0.951)
Electrical	-0.163	-0.0937	-0.279	-0.179
	(0.927)	(0.957)	(0.742)	(0.787)
Chemistry	-0.252	-0.394	-0.230	-0.285
	(0.886)	(0.818)	(0.784)	(0.643)
Biotechnology	0.152	0.270	0.0986	0.128
	(0.942)	(0.897)	(0.915)	(0.862)
Software	-0.621	-0.324	-0.337	-0.133
	(0.724)	(0.850)	(0.690)	(0.832)
Software (BusMeth)				
Software (Not BusMeth)				
MPF Claim Element		-1.525***		-1.619***
		(2.59e-07)		(8.19e-09)
Reissue Patent		0.767		0.371
		(0.868)		(0.746)
Declaratory Judgment		-0.197		-0.270
		(0.521)		(0.314)
District Court Decision		0.512**		0.486**
		(0.0264)		(0.0230)
Foreign Origin		1.127		1.409
		(0.580)		(0.485)
Foreign Priority		-1.453		-1.763
		(0.477)		(0.380)
Post-*Markman*		0.228		0.674***
		(0.533)		(0.00319)
E.D. Tex.		-0.201		-0.0431
		(0.546)		(0.902)
N.D. Cal.		0.346		0.378
		(0.348)		(0.221)
D. Del.		0.191		-0.188
		(0.513)		(0.428)
F-test for Joint Tech. Effects	13.49**	4.112	6.066	2.143
	(0.0192)	(0.533)	(0.300)	(0.829)
N	673	673	673	673

	(5)	(6)	(7)	(8)
	3-level	**3-level**	**5-level**	**5-level**
Mechanical	0.232	0.126	0.131	0.0406
	(0.895)	(0.955)	(0.901)	(0.957)
Electrical	-0.163	-0.0923	-0.280	-0.180
	(0.926)	(0.967)	(0.798)	(0.820)
Chemistry	-0.252	-0.394	-0.230	-0.284
	(0.887)	(0.860)	(0.829)	(0.710)
Biotechnology	0.152	0.266	0.0986	0.125
	(0.943)	(0.916)	(0.930)	(0.882)
Software				
Software (BusMeth)	-0.947	-0.705	-0.589	-0.407
	(0.592)	(0.755)	(0.590)	(0.621)
Software (Not BusMeth)	-0.501	-0.166	-0.251	-0.0290
	(0.774)	(0.941)	(0.812)	(0.970)
MPF Claim Element		-1.513***		-1.610***
		(1.61e-07)		(5.45e-09)
Reissue Patent		0.775		0.378
		(0.874)		(0.747)
Declaratory Judgment		-0.225		-0.283
		(0.517)		(0.297)
District Court Decision		0.504**		0.483**
		(0.0305)		(0.0220)
Foreign Origin		1.180		1.443
		(0.584)		(0.501)
Foreign Priority		-1.570		-1.831
		(0.468)		(0.395)
Post-*Markman*		0.247		0.686***
		(0.500)		(0.00457)
E.D. Tex.		-0.267		-0.0820
		(0.429)		(0.806)
N.D. Cal.		0.373		0.398
		(0.298)		(0.215)
D. Del.		0.241		-0.168
		(0.448)		(0.476)
F-test for Joint Tech. Effects	14.74**	6.081	6.316	3.126
	(0.0224)	(0.414)	(0.389)	(0.793)
N	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)
	3-level	**3-level**	**5-level**	**5-level**
Computer & Other Electronics	-1.872***	-1.941***	-1.421***	-1.618***
	(9.11e-05)	(0.00142)	(2.53e-05)	(0.000155)
Semiconductor	-0.304	-0.149	-0.332	-0.227
	(0.392)	(0.708)	(0.299)	(0.494)
Pharma	-0.0888	-0.0773	-0.139	-0.118
	(0.807)	(0.851)	(0.671)	(0.751)
Pharma (ANDA)				
Pharma (non-ANDA)				
Biotechnology	-0.0225	0.196	-0.165	0.0287
	(0.974)	(0.694)	(0.671)	(0.942)
Medical Devices & Methods	0.0378	0.173	0.000370	0.0137
	(0.889)	(0.589)	(0.999)	(0.963)
Communications	0.0425	0.115	0.160	0.119
	(0.933)	(0.823)	(0.719)	(0.823)
Transportation (Incl. Auto)	-0.530	-0.830	-0.632	-1.050
	(0.359)	(0.219)	(0.360)	(0.191)
Construction	0.459	0.255	0.223	0.0878
	(0.779)	(0.831)	(0.608)	(0.867)
Energy	0.924	1.007	0.480	0.702
	(0.498)	(0.384)	(0.232)	(0.120)
Consumer Goods & Services	0.283	0.259	0.669*	0.659
	(0.422)	(0.511)	(0.0931)	(0.135)
Reissue Patent		-0.130		-0.221
		(0.892)		(0.614)
Declaratory Judgment		0.403		0.506*
		(0.313)		(0.0955)
District Court Decision		0.540*		0.630**
		(0.0613)		(0.0123)
Foreign Origin		1.426		1.352*
		(0.427)		(0.0545)
Foreign Priority		-0.735		-0.740
		(0.686)		(0.332)
Post-*Markman*		-0.618*		-0.304
		(0.0989)		(0.243)
E.D. Tex.		-0.479		-0.654
		(0.740)		(0.408)
N.D. Cal.		-0.472*		-0.316
		(0.0953)		(0.275)
D. Del.		-0.229		-0.136
		(0.424)		(0.628)
F-test for Joint Industry Effects	21.57**	16.26*	29.80***	24.61***
	(0.0174)	(0.0924)	(0.00092)	(0.00613)
N	433	433	433	433

	(5)	(6)	(7)	(8)
	3-level	**3-level**	**5-level**	**5-level**
Computer & Other Electronics	-1.874***	-1.948***	-1.425***	-1.623***
	(7.56e-05)	(0.00043)	(2.43e-05)	(0.000205)
Semiconductor	-0.305	-0.142	-0.333	-0.220
	(0.409)	(0.719)	(0.314)	(0.529)
Pharma				
Pharma (ANDA)	0.178	0.205	0.128	0.0905
	(0.709)	(0.705)	(0.768)	(0.832)
Pharma (non-ANDA)	-0.475	-0.474	-0.548	-0.428
	(0.383)	(0.550)	(0.280)	(0.404)
Biotechnology	-0.0225	0.192	-0.165	0.0277
	(0.964)	(0.713)	(0.679)	(0.943)
Medical Devices & Methods	0.0379	0.181	0.000320	0.0212
	(0.894)	(0.575)	(0.999)	(0.944)
Communications	0.0425	0.122	0.160	0.125
	(0.935)	(0.810)	(0.733)	(0.821)
Transportation (Incl. Auto)	-0.530	-0.830	-0.633	-1.043
	(0.473)	(0.239)	(0.342)	(0.190)
Construction	0.459	0.252	0.223	0.0853
	(0.765)	(0.891)	(0.612)	(0.867)
Energy	0.925	1.006	0.482	0.702
	(0.464)	(0.523)	(0.262)	(0.104)
Consumer Goods & Services	0.283	0.264	0.670*	0.667
	(0.429)	(0.501)	(0.0996)	(0.138)
Reissue Patent		-0.109		-0.192
		(0.887)		(0.696)
Declaratory Judgment		0.426		0.523*
		(0.259)		(0.0955)
District Court Decision		0.524*		0.614**
		(0.0526)		(0.0152)
Foreign Origin		1.432		1.343*
		(0.307)		(0.0529)
Foreign Priority		-0.764		-0.747
		(0.593)		(0.328)
Post-*Markman*		-0.635*		-0.315
		(0.0928)		(0.223)
E.D. Tex.		-0.473		-0.640
		(0.733)		(0.234)
N.D. Cal.		-0.473*		-0.316
		(0.0894)		(0.274)
D. Del.		-0.239		-0.136
		(0.409)		(0.633)
F-test for Joint Industry Effects	22.57**	16.98	31.17***	26.86***
	(0.0203)	(0.108)	(0.00103)	(0.00483)
N	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)
	3-level	**3-level**	**5-level**	**5-level**
Computer & Other Electronics	-0.239	-0.0646	-0.347	-0.215
	(0.589)	(0.889)	(0.388)	(0.632)
Semiconductor	1.567	1.683	0.989**	1.038**
	(0.612)	(0.575)	(0.0221)	(0.0345)
Pharma	-0.546	-0.564	-0.566*	-0.555
	(0.269)	(0.319)	(0.0891)	(0.129)
Pharma (ANDA)				
Pharma (non-ANDA)				
Biotechnology	-0.322	-0.0633	-0.366	-0.147
	(0.512)	(0.909)	(0.487)	(0.796)
Medical Devices & Methods	-0.139	-0.170	-0.262	-0.283
	(0.679)	(0.685)	(0.441)	(0.549)
Communications	-0.0848	-0.423	-0.166	-0.374
	(0.902)	(0.573)	(0.804)	(0.661)
Transportation (Incl. Auto)	-0.129	0.206	0.0814	0.293
	(0.776)	(0.715)	(0.922)	(0.712)
Construction	0.811	1.063	0.450	0.592
	(0.802)	(0.741)	(0.655)	(0.389)
Energy	0.292	0.00164	-0.0665	-0.304
	(0.825)	(0.999)	(0.901)	(0.599)
Consumer Goods & Services	0.778*	1.075**	0.850*	0.967*
	(0.0877)	(0.0320)	(0.0613)	(0.0544)
Reissue Patent		0.190		0.349
		(0.949)		(0.668)
Declaratory Judgment		0.363		0.284
		(0.408)		(0.490)
District Court Decision		-0.112		0.0152
		(0.708)		(0.954)
Foreign Origin		0.625		0.362
		(0.327)		(0.432)
Foreign Priority		0.0835		0.286
		(0.905)		(0.582)
Post-*Markman*		-1.159		-0.463
		(0.194)		(0.146)
E.D. Tex.		0.583		0.182
		(0.692)		(0.798)
N.D. Cal.		0.0902		-0.0201
		(0.819)		(0.960)
D. Del.		0.753*		0.480
		(0.0614)		(0.140)
F-test for Joint Industry Effects	6.861	8.353	19.55**	21.16**
	(0.739)	(0.594)	(0.0338)	(0.0200)
N	299	299	299	299

	(5)	(6)	(7)	(8)
	3-level	**3-level**	**5-level**	**5-level**
Computer & Other Electronics	-0.241	-0.0935	-0.350	-0.236
	(0.600)	(0.843)	(0.389)	(0.596)
Semiconductor	1.577	1.754	1.000**	1.085**
	(0.585)	(0.593)	(0.0241)	(0.0343)
Pharma				
Pharma (ANDA)	0.734	0.947	0.120	0.155
	(0.734)	(0.617)	(0.740)	(0.720)
Pharma (non-ANDA)	-1.672	-1.914	-1.254***	-1.214***
	(0.245)	(0.109)	(0.00145)	(0.00189)
Biotechnology	-0.325	-0.0568	-0.370	-0.140
	(0.517)	(0.925)	(0.486)	(0.819)
Medical Devices & Methods	-0.141	-0.155	-0.263	-0.268
	(0.683)	(0.724)	(0.449)	(0.556)
Communications	-0.0857	-0.433	-0.166	-0.371
	(0.900)	(0.692)	(0.807)	(0.664)
Transportation (Incl. Auto)	-0.130	0.200	0.0801	0.298
	(0.789)	(0.723)	(0.904)	(0.700)
Construction	0.817	1.072	0.457	0.593
	(0.773)	(0.711)	(0.553)	(0.490)
Energy	0.295	-0.0420	-0.0639	-0.327
	(0.812)	(0.978)	(0.951)	(0.573)
Consumer Goods & Services	0.785*	1.105**	0.858*	0.987**
	(0.0841)	(0.0300)	(0.0639)	(0.0473)
Reissue Patent		0.136		0.340
		(0.969)		(0.616)
Declaratory Judgment		0.488		0.344
		(0.308)		(0.409)
District Court Decision		-0.163		-0.0269
		(0.581)		(0.914)
Foreign Origin		0.774		0.414
		(0.483)		(0.379)
Foreign Priority		-0.222		0.152
		(0.846)		(0.776)
Post-*Markman*		-1.432		-0.547*
		(0.103)		(0.0819)
E.D. Tex.		0.674		0.210
		(0.582)		(0.774)
N.D. Cal.		0.0882		-0.0288
		(0.834)		(0.941)
D. Del.		0.685		0.432
		(0.108)		(0.189)
F-test for Joint Industry Effects	7.790	9.307	28.97***	28.79***
	(0.732)	(0.594)	(0.00229)	(0.00244)
N	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)
	3-level	**3-level**	**5-level**	**5-level**
Computer & Other Electronics	0.0691	0.0892	0.362	0.249
	(0.807)	(0.797)	(0.193)	(0.458)
Semiconductor	0.462	0.827	-0.266	0.0460
	(0.841)	(0.680)	(0.456)	(0.917)
Pharma	-0.0670	-0.306	-0.0187	-0.168
	(0.838)	(0.384)	(0.944)	(0.592)
Pharma (ANDA)				
Pharma (non-ANDA)				
Biotechnology	15.28***	13.31***	1.440	1.180
	(0)	(0)	(0.743)	(0.811)
Medical Devices & Methods	0.182	0.0388	0.0625	-0.0589
	(0.571)	(0.914)	(0.812)	(0.846)
Communications	-0.185	0.128	-0.148	0.109
	(0.610)	(0.739)	(0.647)	(0.755)
Transportation (Incl. Auto)	0.647	0.425	0.865	0.648
	(0.365)	(0.622)	(0.291)	(0.449)
Construction	0.473	0.307	0.339	0.265
	(0.717)	(0.848)	(0.473)	(0.602)
Energy	0.806	0.426	0.689	0.262
	(0.620)	(0.723)	(0.304)	(0.717)
Consumer Goods & Services	0.235	0.0881	0.325	0.158
	(0.473)	(0.803)	(0.264)	(0.610)
MPF Claim Element		-1.620***		-1.612***
		(3.13e-08)		(1.40e-09)
Reissue Patent		0.842		0.383
		(0.867)		(0.762)
Declaratory Judgment		-0.0814		-0.202
		(0.796)		(0.447)
District Court Decision		0.528**		0.461**
		(0.0252)		(0.0290)
Foreign Origin		1.178		1.436
		(0.561)		(0.544)
Foreign Priority		-1.466		-1.762
		(0.472)		(0.458)
Post-*Markman*		0.182		0.608***
		(0.605)		(0.00837)
E.D. Tex.		-0.292		-0.0708
		(0.364)		(0.832)
N.D. Cal.		0.281		0.395
		(0.416)		(0.205)
D. Del.		0.150		-0.193
		(0.635)		(0.427)
F-test for Joint Industry Effects	675.5	276.6	6.693	2.642
	(0)	(0)	(0.754)	(0.989)
N	673	673	673	673

	(5)	(6)	(7)	(8)
	3-level	**3-level**	**5-level**	**5-level**
Computer & Other Electronics	0.0691	0.105	0.363	0.265
	(0.817)	(0.757)	(0.207)	(0.424)
Semiconductor	0.462	0.837	-0.266	0.0589
	(0.818)	(0.708)	(0.468)	(0.893)
Pharma				
Pharma (ANDA)	1.127	0.862	0.969	0.722
	(0.664)	(0.797)	(0.308)	(0.531)
Pharma (non-ANDA)	-0.665*	-0.920**	-0.594*	-0.682*
	(0.0608)	(0.0244)	(0.0697)	(0.0505)
Biotechnology	13.62***	13.33***	1.442	1.194
	(0)	(0)	(0.751)	(0.801)
Medical Devices & Methods	0.182	0.0493	0.0627	-0.0512
	(0.579)	(0.893)	(0.816)	(0.861)
Communications	-0.185	0.133	-0.148	0.111
	(0.601)	(0.728)	(0.637)	(0.756)
Transportation (Incl. Auto)	0.647	0.443	0.867	0.667
	(0.513)	(0.549)	(0.287)	(0.204)
Construction	0.473	0.307	0.339	0.269
	(0.666)	(0.798)	(0.601)	(0.602)
Energy	0.806	0.413	0.690	0.249
	(0.491)	(0.789)	(0.136)	(0.626)
Consumer Goods & Services	0.235	0.105	0.326	0.175
	(0.476)	(0.758)	(0.275)	(0.584)
MPF Claim Element		-1.619***		-1.611***
		(1.00e-09)		(1.58e-08)
Reissue Patent		0.816		0.364
		(0.863)		(0.759)
Declaratory Judgment		-0.0791		-0.200
		(0.792)		(0.463)
District Court Decision		0.513**		0.453**
		(0.0432)		(0.0382)
Foreign Origin		1.230		1.487
		(0.515)		(0.352)
Foreign Priority		-1.464		-1.778
		(0.437)		(0.267)
Post-*Markman*		0.0798		0.541**
		(0.826)		(0.0222)
E.D. Tex.		-0.272		-0.0510
		(0.410)		(0.874)
N.D. Cal.		0.241		0.374
		(0.508)		(0.253)
D. Del.		0.239		-0.114
		(0.442)		(0.662)
F-test for Joint Industry Effects	460	291.2	14.32	9.296
	(0)	(0)	(0.216)	(0.595)
N	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.

Table A10. Linear Probability Two-Level Outcomes by Technology

	Enablement		**Written Description**		**Claim Definiteness**	
	Combined	**Primary**	**Combined**	**Primary**	**Combined**	**Primary**
Mechanical	0.0989	0.205	0.0756	0.0581	0.0103	0.00544
	(0.243)	(0.139)	(0.429)	(0.831)	(0.877)	(0.952)
Electrical	0.0165	0.139	0.298***	0.194	-0.0272	-0.00601
	(0.850)	(0.358)	(5.88e-05)	(0.492)	(0.605)	(0.951)
Chemistry	0.0332	0.128	0.0686	-0.00231	-0.0366	-0.0405
	(0.744)	(0.377)	(0.545)	(0.993)	(0.603)	(0.666)
Biotech-nology	0.00764	0.104	0.0329	-0.0239	0.0335	0.0288
	(0.946)	(0.509)	(0.794)	(0.931)	(0.692)	(0.779)
Software (BusMeth)	-0.148	-0.0314	-0.349**	-0.381	-0.133	-0.140
	(0.573)	(0.905)	(0.0240)	(0.199)	(0.115)	(0.180)
Software (Not BusMeth)	-0.336***	-0.277*	-0.0416	-0.0421	-0.0107	-0.0362
	(0.000366)	(0.0699)	(0.653)	(0.885)	(0.868)	(0.696)
MPF Claim Element					-0.315***	-0.312***
					(5.39e-08)	(1.16e-07)
Reissue Patent	0.0312	0.0597	0.0270	0.0398	0.0534	0.0516
	(0.833)	(0.695)	(0.851)	(0.750)	(0.463)	(0.481)
Declara-tory Judgment	-0.0437	-0.0311	0.0828	0.0525	-0.00463	-0.00713
	(0.470)	(0.616)	(0.392)	(0.598)	(0.923)	(0.879)
District Ct. Decision	0.240***	0.227***	0.0910	0.102	0.117***	0.115***
	(2.32e-05)	(4.56e-05)	(0.156)	(0.119)	(0.00412)	(0.00282)
Foreign Origin	0.311*	0.307*	0.135	0.183	0.117**	0.115*
	(0.0567)	(0.0582)	(0.381)	(0.200)	(0.0497)	(0.0511)
Foreign Priority	-0.291*	-0.286*	0.00128	-0.0685	-0.143**	-0.138**
	(0.0920)	(0.0831)	(0.994)	(0.653)	(0.0400)	(0.0490)
Post-*Markman*	-0.102	-0.0887	-0.300***	-0.295***	-0.0236	-0.0210
	(0.125)	(0.171)	(5.06e-05)	(0.000129)	(0.619)	(0.655)
E.D. Tex.	-0.262*	-0.245*	-0.130	-0.0676	-0.0690	-0.0580
	(0.0552)	(0.0751)	(0.503)	(0.686)	(0.164)	(0.233)
N.D. Cal.	0.0974	0.0926	0.0686	0.0432	0.0627	0.0651
	(0.454)	(0.467)	(0.603)	(0.740)	(0.190)	(0.158)
D. Del.	-0.0840	-0.0814	0.0895	0.0864	0.0519	0.0555
	(0.204)	(0.205)	(0.262)	(0.275)	(0.213)	(0.189)
N	324	324	215	215	633	633

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

Table A11. Linear Probability Two-Level Outcomes by Industry

	Enablement	**Written Description**	**Indefiniteness**
Computer & Other Electronics	-0.510***	-0.111	0.0281
	(1.11e-05)	(0.417)	(0.584)
Semiconductor	-0.0114	0.307***	0.140
	(0.930)	(0.00851)	(0.112)
Pharma (ANDA)	0.0141	0.124	0.182***
	(0.892)	(0.460)	(9.25e-06)
Pharma (Non-ANDA)	-0.0598	-0.486***	-0.115
	(0.655)	(0.000740)	(0.227)
Biotechnology	0.0513	-0.0691	0.174***
	(0.641)	(0.656)	(9.96e-06)
Medical Devices & Methods	0.0844	-0.0101	0.0203
	(0.221)	(0.926)	(0.703)
Communications	-0.00956	-0.187	0.0244
	(0.940)	(0.268)	(0.690)
Transportation (Incl. Auto)	-0.130	0.0967	0.0468
	(0.367)	(0.632)	(0.457)
Construction	-0.0130	0.223	0.0370
	(0.924)	(0.176)	(0.614)
Energy	0.137	-0.0809	0.0557
	(0.232)	(0.621)	(0.452)
Consumer Goods & Services	0.0973	0.247**	0.0253
	(0.259)	(0.0170)	(0.616)
MPF Claim Element			-0.331***
			(4.90e-08)
Reissue Patent	0.0422	-0.0942	0.0552
	(0.777)	(0.470)	(0.446)
Declaratory Judgment	0.0669	0.130	0.00236
	(0.334)	(0.233)	(0.959)
District Court Decision	0.215***	0.0469	0.118***
	(0.000297)	(0.497)	(0.00193)
Foreign Origin	0.348**	0.190	0.129*
	(0.0183)	(0.158)	(0.0651)
Foreign Priority	-0.360**	-0.0771	-0.144*
	(0.0194)	(0.621)	(0.0725)
Post-*Markman*	-0.0854	-0.442***	-0.0493
	(0.221)	(1.87e-05)	(0.303)
E.D. Tex.	-0.235	0.157	-0.0654
	(0.103)	(0.392)	(0.176)
N.D. Cal.	0.0790	0.0245	0.0399
	(0.476)	(0.851)	(0.361)
D. Del.	-0.0590	0.120	0.0471
	(0.384)	(0.170)	(0.279)
N	324	215	633

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