

PRIOR ART IN THE DISTRICT COURT

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This Article is an empirical study of the evidence district courts rely upon when invalidating patents. To construct our dataset, we collected every district court ruling, verdict form, and opinion (whether reported or unreported) invalidating a patent claim over a six-and-a-half-year period. We then coded individual invalidity rulings based on the prior art supporting the court's decision, observing 3320 invalidation events relying on 817 distinct prior art references.

The nature of the prior art relied upon to invalidate patents is relevant to two distinct sets of policy questions. First, this data sheds light on the value of district court litigation as an error-correction tool. As prior work has shown, the public interest in revoking erroneous patent grants depends on the reason those grants were undeserved. Second, this data sheds light on the feasibility of discovering invalidating prior art during patent examination. Depending on the ease of finding the relevant prior art, it may or may not be cost effective to replace patent litigation with a different approach to error correction, such as investing more effort in examination-stage scrutiny.

The conclusions here are mixed. On one hand, invalidations for lack of novelty bear many indicia of publicly beneficial error correction. Anticipation based on obscure prior art appears to be quite rare. When it comes to obviousness, however, a significant number of invalidations rely on prior art that would have been difficult or impossible to find at the time of invention. This complicates—though does not necessarily refute—the traditional view that obviousness challenges ought to be proactively encouraged.

INTRODUCTION	838
I. BACKGROUND.....	842
A. <i>Why the Value of Litigation Depends on Prior Art</i>	842
B. <i>Prior Work</i>	848
II. METHODOLOGY	851
A. <i>Collection and Coding</i>	851
B. <i>Reproducibility and Selection Effects</i>	855
III. PRIOR ART IN THE DISTRICT COURT	858
A. <i>Anticipation vs. Obviousness</i>	858
B. <i>Categories of Prior Art</i>	860
C. <i>Printed Publications</i>	862

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D. U.S. Patents as Prior Art	865
E. Activity	869
F. Foreign Patents	873
IV. POTENTIAL BENEFITS OF REPLACING LITIGATION WITH EXAMINATION	876
A. Prior Art and Examination Time	878
B. Examining for Anticipation	881
C. Examining for Obviousness	883
V. REASONS FOR INFERENTIAL CAUTION AND FUTURE WORK	888
A. Invalidity Basis is Changing Over Time	888
B. IPR Selection Effects	890
C. Changes in Prior Art Rules	891
CONCLUSION	892

INTRODUCTION

Patent litigation is complicated, fact intensive, and expensive. Nonetheless, for at least fifty years, the Supreme Court has pursued an express policy of welcoming patent disputes into court and discouraging patent settlement.¹ Citing the public's "paramount interest" in patent adjudication,² the Court has abrogated traditional doctrines like licensee estoppel,³ applied non-mutual claim preclusion to patentees,⁴ changed the rules of appellate court procedure,⁵ and subjected settling patent litigants to potential antitrust liability.⁶ All of this to drum up more patent litigation and guide it toward final judgment.

Standing alone, this policy is a bit puzzling, occurring as it does within a court system that typically encourages settlement.⁷ But the puzzle is only compounded when one realizes just how exceptional this pro-litigation posture makes patent law. Among the many kinds of civil cases one might think serve a public interest—First Amendment litigation, civil rights suits, challenges to agency actions, and so on—only *patent litigation* has been anointed

1 See, e.g., *Medtronic, Inc. v. Mirowski Family Ventures, LLC*, 134 S. Ct. 843, 851–52 (2014); *FTC v. Actavis, Inc.*, 133 S. Ct. 2223, 2237 (2013); *Cardinal Chem. Co. v. Morton Int'l, Inc.*, 508 U.S. 83, 100–01, 101 n.24 (1993); *Blonder-Tongue Labs., Inc. v. Univ. of Ill. Found.*, 402 U.S. 313, 343–44 (1971); *Lear, Inc. v. Adkins*, 395 U.S. 653, 673–74 (1969).

2 *Blonder-Tongue*, 402 U.S. at 343 (quoting *Precision Instrument Mfg. Co. v. Auto. Maint. Mach. Co.*, 324 U.S. 806, 816 (1945)).

3 See *Lear*, 395 U.S. at 670.

4 See *Blonder-Tongue*, 402 U.S. at 343, 350.

5 See *Cardinal Chem.*, 508 U.S. at 100–02.

6 See *Actavis*, 133 S. Ct. at 2232, 2234.

7 See *id.* at 162 (Roberts, C.J., dissenting) (“[The parties’ patent settlement] put an end to litigation that had been dragging on for three years. Ordinarily, we would think this a good thing.”); see also FED. R. CIV. P. 16(c) advisory committee’s note to 1983 amendment.

for judicial encouragement.⁸ What is it that makes patent cases so special, that they should be encouraged while almost every other type of civil suit is quietly counseled out of the courtroom?

While the Supreme Court's answers to that question have been terse,⁹ scholars have explored the public benefits of patent litigation in some detail.¹⁰ At a high level, there are two distinct theories of how patent litigation might serve the public interest. The first is that judicial scrutiny of an issued patent may end a "patent monopoly," thereby increasing competition to the benefit of consumers.¹¹ The second is that revoking an undeserved patent may send a signal to prospective inventors about the need to comply

8 See, e.g., *Wygant v. Jackson Bd. of Educ.*, 476 U.S. 267, 305 (1986) (Marshall, J., dissenting) ("[C]ivil rights litigation is no exception to the general policy in favor of settlements."); *United States v. Davis*, 261 F.3d 1, 27 (1st Cir. 2001) (observing a "strong public policy in favor of settlements, particularly in very complex and technical regulatory contexts" (quoting *United States v. Comunidades Unidas Contra la Contaminacion*, 204 F.3d 275, 280 (1st Cir. 2000))); *Doe v. Delie*, 257 F.3d 309, 322 (3d Cir. 2001) ("The law favors settlement, particularly in class actions and other complex cases, to conserve judicial resources and reduce parties' costs."); *Flex-Foot, Inc. v. CRP, Inc.*, 238 F.3d 1362, 1369 (Fed. Cir. 2001) ("'[T]here is a compelling public interest and policy in upholding and enforcing settlement agreements voluntarily entered into' because enforcement of settlement agreements encourages parties to enter into them—thus fostering judicial economy." (quoting *Hemstreet v. Spiegel, Inc.*, 851 F.2d 348, 350 (Fed. Cir. 1988))).

9 Perhaps the most detailed explanation the Court has offered came in 1945, when the Court explained that because of the "far-reaching social and economic consequences of a patent," the public has "a paramount interest in seeing that patent monopolies spring from backgrounds free from fraud or other inequitable conduct and that such monopolies are kept within their legitimate scope." *Precision Instrument Mfg. Co. v. Auto. Maint. Mach. Co.*, 324 U.S. 806, 816 (1945). In more recent opinions, the benefits of patent litigation are simply taken as a given. See, e.g., *Oil States Energy Servs., LLC v. Greene's Energy Grp., LLC*, 138 S. Ct. 1365, 1374 (2018) (citing "the public's paramount interest in seeing that patent monopolies are kept within their legitimate scope" (quoting *Cuozzo Speed Techs., LLC v. Lee*, 136 S. Ct. 2131, 2144 (2016))); *SAS Inst., Inc. v. Iancu*, 138 S. Ct. 1348, 1363 (2018) (Breyer, J., dissenting) (same).

10 See, e.g., Michael J. Burstein, *Rethinking Standing in Patent Challenges*, 83 GEO. WASH. L. REV. 498, 538–41 (2015); Einer Elhauge & Alex Krueger, *Solving the Patent Settlement Puzzle*, 91 TEX. L. REV. 283, 293–95 (2012); Joseph Farrell & Robert P. Merges, *Incentives to Challenge and Defend Patents: Why Litigation Won't Reliably Fix Patent Office Errors and Why Administrative Patent Review Might Help*, 19 BERKELEY TECH. L.J. 943, 945–47 (2004); Jay P. Kesan & Andres A. Gallo, *Why "Bad" Patents Survive in the Market and How Should We Change?—The Private and Social Costs of Patents*, 55 EMORY L.J. 61, 76–77, 90–92 (2006); Christopher R. Leslie, *The Anticompetitive Effects of Unenforced Invalid Patents*, 91 MINN. L. REV. 101, 125–27, 179 (2006); Anup Malani & Jonathan S. Masur, *Raising the Stakes in Patent Cases*, 101 GEO. L.J. 637, 657 (2013); Matthew Sag & Kurt Rohde, *Patent Reform and Differential Impact*, 8 MINN. J.L. SCI. & TECH. 1, 9–11 (2007); R. Polk Wagner, *Understanding Patent-Quality Mechanisms*, 157 U. PA. L. REV. 2135, 2142–45 (2009); Robert C. Dorr, Note, *Patent Law—Patent Validity: The Public Is the Third Party*, 51 DENV. L.J. 95, 113 (1974); see also FED. TRADE COMM'N, TO PROMOTE INNOVATION: THE PROPER BALANCE OF COMPETITION AND PATENT LAW AND POLICY, ch. 1, at 6, 11, 14 (2003), <http://perma.cc/D4DC-WGC7>.

11 See Stephen Yelderman, *Do Patent Challenges Increase Competition?*, 83 U. CHI. L. REV. 1943, 1951–53 (2016) [hereinafter Yelderman, *Increasing Competition*].

with the substantive demands of patent law, thereby increasing the incentivizing power of the patent system in the future.¹² Though it is possible for patent litigation to yield other benefits, these are the two patent-specific theories that have been most extensively developed and that are consistently invoked to support policies of encouraging patent litigation.¹³

But both of these are only theories. To actually justify our longstanding policy of encouraging patent litigation, we need to know quite a bit about the particulars of how patent cases play out in practice. Under either theory, the public benefits of patent litigation can turn quite dramatically depending on the circumstances of a given case.¹⁴ For example, it is possible that most patent cases vindicate the public domain based on prior art that the purported inventor should have known about. But it is also possible that many cases actually involve faultless inventors embroiled in fact-bound disputes with primarily private significance. To fully assess the public interest in patent litigation, we need to know something about the evidence underlying judicial determinations of invalidity.¹⁵

To this point, we have known very little. While prior studies have reported the raw number of patents invalidated under various statutory provisions,¹⁶ no study has examined the evidence supporting those conclusions. We know, for example, that among all patent cases filed in 2008 and 2009, 154 summary judgment motions were filed on the basis of anticipation,¹⁷ and that 31 of those motions ultimately succeeded.¹⁸ But we have no idea whether those invalidations involved a strong public interest, or whether they would be better characterized as private fights over the technicalities of patent law.¹⁹ So while the value of patent litigation has been vigorously theorized, the data necessary to test those theories has so far been lacking.

This Article provides the first comprehensive look at the evidence district courts rely upon when invalidating patents. To construct our dataset, we collected every district court ruling, verdict form, and opinion (whether

12 See Stephen Yelderman, *The Value of Accuracy in the Patent System*, 84 U. CHI. L. REV. 1217, 1283–84 (2017) [hereinafter Yelderman, *Value of Accuracy*].

13 In my prior work (and in this Article), I focus on theories that could potentially justify the patent law exception to the ordinary preference for settlement. See Yelderman, *Increasing Competition*, *supra* note 11, at 1950–51. I therefore do not consider theories of benefit that would be shared with other kinds of civil cases—for example, the creation of precedent. See, e.g., Owen M. Fiss, *Against Settlement*, 93 YALE L.J. 1073, 1082–84 (1984).

14 See Yelderman, *Increasing Competition*, *supra* note 11, at 1994–95; Yelderman, *Value of Accuracy*, *supra* note 12, at 1283–84.

15 See Yelderman, *Value of Accuracy*, *supra* note 12, at 1283–84.

16 See, e.g., John R. Allison, Mark A. Lemley & David L. Schwartz, *Understanding the Realities of Modern Patent Litigation*, 92 TEX. L. REV. 1769, 1785 (2014) [hereinafter Allison et al., *Realities of Modern Patent Litigation*].

17 *Id.* at 1770, 1782. Anticipation (lack of novelty under 35 U.S.C. § 102) is one of two legal bases requiring evidence of prior art. 35 U.S.C. § 102 (2006). The other is obviousness, codified in § 103. 35 U.S.C. § 103 (2012).

18 Allison et al., *Realities of Modern Patent Litigation*, *supra* note 16, at 1770, 1785.

19 See *infra* Section I.B.

reported or unreported) invalidating a patent claim over a recent six-and-a-half-year period. We then coded individual invalidation events on a reference-by-reference, claim-by-claim basis. In the end, we observed 3320 invalidation events based on 817 distinct prior art references.

This data sheds critical light on the public value of patent litigation. And it turns out to reveal starkly different answers depending on the legal issue in a case. Invalidations based on anticipation bear many indicia of publicly beneficial error correction. Encouragingly, invalidity based on obscure prior art appears to be rare. This suggests that the bulk of anticipation invalidations have the potential to incentivize future inventors.

But the story is not so rosy for cases of obviousness. A significant number of obviousness invalidations rely on prior art that would have been difficult or impossible to find at the time of invention. This suggests that many obviousness invalidations lack the potential for incentivization found in cases of anticipation and may even be *disincentivizing* for inventors who lose patents on the basis of facts they simply could not have known. This does not mean litigation of these cases is necessarily undesirable—these cases may yet be justified under some *other* theory of how patent litigation benefits the public.²⁰ But, at a minimum, the data fails to show that the prevailing policy of encouraging obviousness litigation has a sound empirical basis.

Aside from the public value of patent litigation, this data is relevant to another set of policy questions as well: whether it would be cost effective to allocate more time and money to the initial process of patent examination. For more than a decade, the consensus view—forged by Mark Lemley’s highly influential article, *Rational Ignorance at the Patent Office*²¹—has been that increased investment in patent examination would cost more than it would save.²² In recent years, scholars have questioned this premise, suggesting that better patent examination *could* justify its costs by significantly reducing the need for patent litigation.²³ We offer a new perspective on this debate by assessing the feasibility of patent examiners actually finding the prior art that later proves fatal in court. We conclude that Lemley’s original predictions were implausibly low, but that the latest scholarship rebutting Lemley’s work appears quite optimistic. While increased investment in examination may still turn out to be cost justified, our findings suggest that litigation savings will not be as large as recent scholarship has predicted.

To be clear from the outset, this is a study of district court litigation as an error-correction tool, *not* a study of patent quality. All of our observations are drawn from patents that were litigated to a judicial decision, and these may not be representative of all patents in general or even litigated patents in general. Because only a tiny fraction of issued patents are ever asserted, and only a tiny fraction of *those* are litigated to a decision, the potential for selec-

20 See *infra* Section I.A.

21 Mark A. Lemley, Essay, *Rational Ignorance at the Patent Office*, 95 NW. U. L. REV. 1495 (2001).

22 See *id.* at 1496–97.

23 See *infra* Part IV.

tion effects is significant.²⁴ This data sheds light on the nature of the error correction afforded by district courts and the feasibility of providing that same error correction through alternative mechanisms, but should not be used to make any inferences about the nature of patent invalidity overall.

This Article proceeds in five parts. Part I explains why the public benefits of patent litigation depend on the prior art at issue in a case and briefly recounts prior studies of district court patent litigation. Part II introduces the sources and methodology used in this study. Part III presents our findings related to the public value of patent litigation. Part IV explores the likelihood that increased investment in examination could avoid the need for patent adjudication. Part V discusses several reasons for inferential caution and suggests avenues for future work. A brief conclusion follows.

I. BACKGROUND

Before turning to the methodology of this study, two pieces of background are in order. Section A explains why the value of patent litigation can depend on the prior art at issue in a case. Section B then briefly discusses several prior studies of district court patent litigation and explains why they are insufficient to address the questions of interest here.

A. *Why the Value of Litigation Depends on Prior Art*

Courts and scholars have long heralded the public benefits of patent litigation. For nearly a century, the public's "paramount interest" in ensuring that patents are "free from fraud" and "kept within their legitimate scope" was accepted as a self-evident proposition that required neither proof nor elaboration.²⁵ Today, courts, commentators, and litigants often cite the public benefits of patent litigation as if they were simply an accepted fact.²⁶

24 See *infra* Section II.B.

25 Precision Instrument Mfg. Co. v. Auto. Maint. Mach. Co., 324 U.S. 806, 816 (1945); see also Pope Mfg. Co. v. Gormully, 144 U.S. 224, 234 (1892); Yelderman, *Increasing Competition*, *supra* note 11, at 1951–58 (collecting similar claims about the public's interest in patent litigation).

26 See *supra* notes 9–10 (collecting court decisions and commentary). Given the Supreme Court's long history of asserting the public interest in patent litigation, it is no surprise that litigants cite these benefits as well. See, e.g., Brief Amici Curiae for Sixteen Intellectual Property Law Professors in Support of the Respondent, Commil USA, LLC v. Cisco Sys., Inc., 135 S. Ct. 1920 (2015) (No. 13-896), 2015 WL 860735, at *8 (arguing that a particular mens rea rule for secondary liability would "inappropriately discourage[] challenges to patents" (capitalization altered)); Petition for a Writ of Certiorari at 15, Nichia Corp. v. Everlight Elecs. Co., 139 S. Ct. 183 (2018) (mem.) (No. 17-1707), 2018 WL 3141455 (arguing that patent validity is a question of law because "the proper scope of patents implicates the public interest" (capitalization altered)); Petition for a Writ of Certiorari at i, EVE-USA, Inc. v. Mentor Graphics Corp., 139 S. Ct. 44 (2018) (mem.) (No. 17-804), 2017 WL 6018229 (invoking the "important public interest of eliminating invalid patents" in the Questions Presented).

It is one thing to tout the benefits of patent litigation; it is another to propose a defensible theory of how adjudication of patent cases might yield public benefits not found in other forms of civil litigation. Prior scholarship has primarily focused on two distinct theories of how patent cases might uniquely serve the public interest. The first theory is that revoking a patent can reduce or eliminate market power, thereby increasing competition and freeing the public from the burden of a “patent monopoly.”²⁷ The second theory is that revoking a patent denies the patent holder the benefit of something she did not deserve, thus sharpening incentives for inventors to comply with the substantive demands of patent law in the future.²⁸ The first theory is about reducing the costs of individual patents; the second is about enforcing the patent bargain to improve ex ante incentives.

The first theory is important, but it is not the subject of this Article. As I have shown in earlier work, the possibility that a patent challenge may increase competition is highly case specific, depending on factors such as who wins, how quickly the case is resolved, whether there are other intellectual property rights at play, and other details about the patent in suit and the structure of the relevant market.²⁹ In some identifiable categories of cases, the potential benefits for competition can be significant; in others, they can be quite small.³⁰ The prior art used to invalidate a patent is generally not relevant to drawing this distinction. Therefore, this theory will be largely set aside for purposes of the following discussion, keeping in mind that it may justify litigation in some cases in which the second theory does not.

Another reason we might want to encourage patent litigation is that revoking undeserved patents can sharpen incentives for future inventors—and this theory *is* the subject of this Article. As my prior work explores in detail, the incentivizing power of any promise depends both on the accurate reward of benefits when they are deserved and on the accurate denial of those benefits when they are undeserved.³¹ Revoking an undeserved patent fulfills the negative promise implicit in the rewards scheme, thus increasing the power of the offered rewards in the future.³² In this way, successful patent challenges serve the public interest by denying the benefits of patents to those who did not hold up their end of the patent bargain.

Like the first, this theory is case specific. Some patent disputes center on conduct that the patent system actively seeks to encourage or discourage—such as a claim that the supposed “inventor” had in fact stolen the invention from someone else.³³ But other patent cases aren’t like that. Instead, they are really just fights over technicalities that do not strongly implicate the pat-

27 See Yelderman, *Increasing Competition*, *supra* note 11, at 1951–54 (summarizing this theory).

28 See Yelderman, *Value of Accuracy*, *supra* note 12, at 1221, 1221 n.13, 1281–84.

29 See Yelderman, *Increasing Competition*, *supra* note 11, at 1960–61.

30 *Id.* at 1960, 1994–95.

31 See Yelderman, *Value of Accuracy*, *supra* note 12, at 1221.

32 *Id.* at 1247–48.

33 See *id.* at 1266.

ent bargain—such as pinning down exactly how difficult it would have been for a hypothetical researcher to find a particular undergraduate thesis on the shelf of a university library.³⁴ When an inventor fails to satisfy the patentability requirements in a case like that, revoking her patent does not sharpen incentives to behave differently in the future—she has done everything patent law demanded of her, yet is denied patent protection all the same. This second theory of benefit justifies patent litigation only in cases in which the inventor faced a mutually exclusive choice and made a decision contrary to the aims of patent law.³⁵

The power of this incentives-based theory is that it can significantly reduce the potential range of optimal-error rates in the patent system. With some basic assumptions about the observability of errors, the incentives-based theory can show that patents should be awarded only when there is at least a fifty percent chance that they are actually deserved.³⁶ This, in turn, provides qualified support for longstanding policies designed to increase rates of patent adjudication.³⁷ But there is a limit. When a patent is revoked for reasons beyond the inventor's control, the inventor faces no relevant mutually exclusive choice, and the inventor-incentivizing benefit is unavailable. In those cases, revoking an invalid patent may actually be *disincentivizing*, since it reduces the correlation between conduct and outcome, thereby weakening the power of the patent promise. This does not mean these cases necessarily lack value—in fact, they may still be justified on some other grounds. But as far as the inventor-incentivizing theory goes, the benefits of adjudication are limited to cases in which inventors lose patent rights as a result of things they could have plausibly controlled.³⁸

Litigation involving some patentability doctrines will reliably satisfy this condition. For example, the enablement requirement is specifically designed to coerce patent applicants to teach the public how to use the invention.³⁹ When an applicant fails to sufficiently disclose an invention and her patent is consequently taken away, the fault is entirely her own. No extrinsic factors or moral luck intercedes between the conduct patent law seeks to influence and the outcome patent law provides. Provided they are observable, these are reliably inventor-incentivizing error corrections.

For other patentability doctrines, however, the path from conduct to outcome is more roundabout. In particular, when a patent is revoked because it was anticipated or obvious in light of prior art, the inventor's culpability in having originally sought that patent turns significantly on the

34 See *In re Cronyn*, 890 F.2d 1158, 1161 (Fed. Cir. 1989).

35 See Yelderman, *Value of Accuracy*, *supra* note 12, at 1242–43.

36 See *id.* at 1251–56.

37 See *id.* at 1281–83.

38 Cf. Louis Kaplow, *The Value of Accuracy in Adjudication: An Economic Analysis*, 23 J. LEGAL STUD. 307, 313–14, 332 (1994) (observing that greater accuracy in adjudication can be a waste of resources if actors lack the same information at the moment of their decisionmaking).

39 See Yelderman, *Value of Accuracy*, *supra* note 12, at 1263–65.

nature of the prior art itself.⁴⁰ These two patentability doctrines constitute the majority of all postgrant patent revocations.⁴¹ And yet it is impossible to say whether these revocations are inventor-incentivizing without knowing something about the prior art underlying that decision.

To see why, consider the anticipation doctrine (sometimes called the “novelty” requirement).⁴² A patent claim is anticipated only when all of the elements of the claim can be found in a single prior art reference. Critically, a factfinder may not combine multiple references to establish anticipation.⁴³ For that reason, the anticipation inquiry is quite straightforward. The factfinder simply compares the prior art to the patent claim to see if there is a match.⁴⁴

The value of commissioning that comparison depends greatly on what, exactly, we are asking the factfinder to compare the claim to. For example, a patent can be anticipated because the inventor published her idea long before patenting, sat on the sideline for years, and then sought patent protection only after the idea caught on. This behavior creates serious hold-up problems for the public and is something patent law very much seeks to discourage.⁴⁵ Catching such cases, therefore, is a strongly incentivizing form of error correction. In addition, even in cases in which the inventor did not actually know about the prior art at the time, denying patent protection based on reasonably discoverable prior art encourages future inventors to seek out existing solutions before wastefully reinventing the wheel.⁴⁶ So when the inventor could have discovered the anticipating prior art with a reasonable amount of searching, revoking her patent is also a strongly incentivizing form of error correction.

40 See 35 U.S.C. § 102 (2006); 35 U.S.C. § 103 (2012).

41 Historically, anticipation and obviousness comprised the vast majority of patent-level invalidity events in district court. See Allison et al., *Realities of Modern Patent Litigation*, *supra* note 16, at 1782; *infra* Section IV.A. The number of *district court* invalidations based on prior art has declined in recent years, but this reduction has been more than offset by the introduction of inter partes review. See *infra* Part V.

42 See 35 U.S.C. § 102 (2006). Note that § 102 was reorganized and substantively changed in several ways by the Leahy-Smith America Invents Act (AIA), Pub. L. No. 112-29, 125 Stat. 284 (2011) (codified at 35 U.S.C. § 102 (2012)). Unless otherwise noted, references to § 102 refer to the pre-AIA version of the statute, which was the applicable law for ninety-nine percent of the invalidations in our dataset. The possibility that district courts may use prior art differently when applying post-AIA law is addressed in Section V.C.

43 See *Atlas Powder Co. v. Ireco, Inc.*, 190 F.3d 1342, 1346 (Fed. Cir. 1999).

44 See *id.* To be sure, in ways that are not relevant here, this seemingly simple comparison can become more complicated. For example, the court may need to first determine what the challenged claim means, whether the asserted prior art reference has any undisclosed but “inherent” features, see *id.* at 1346–47 (discussing claim construction and inherency), and whether the asserted prior art reference is enabled, see *Rasmusson v. SmithKline Beecham Corp.*, 413 F.3d 1318, 1325–26 (Fed. Cir. 2005) (discussing enablement).

45 See *Pfaff v. Wells Elecs., Inc.*, 525 U.S. 55, 63–65 (1998).

46 See ROBERT PATRICK MERGES & JOHN FITZGERALD DUFFY, *PATENT LAW AND POLICY* 401–02 (6th ed. 2013); Yelderman, *Value of Accuracy*, *supra* note 12, at 1267–68.

But anticipation can also rely on obscure prior art, things which the inventor did not know about and could not *possibly* have found—such as an unpublished illustration discoverable only by travelling in person to the Canadian patent office.⁴⁷ Invalidations like these are not an incentivizing form of error correction; the inventor cannot seriously be blamed for failing to travel to every patent office in the world. When the only reason a patent is invalid is that obscure prior art anticipated the invention, the inventor is perhaps unlucky, but has done nothing that patent law affirmatively seeks to discourage.⁴⁸ The difference between valuable enforcement of the patent bargain and a defendant escaping on a technicality depends on the availability of the anticipating prior art.

The other way that prior art can invalidate a claim is through the obviousness doctrine. Even in cases in which the claimed invention is not anticipated, it may be invalid “if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious.”⁴⁹ As the Supreme Court has explained, “The nonobviousness requirement extends the field of unpatentable material beyond that which is [anticipated], to include that which could readily be deduced from publicly available material by a person of ordinary skill in the pertinent field of endeavor.”⁵⁰

In contrast to the rigid rules of anticipation, the obviousness determination requires an “expansive and flexible approach.”⁵¹ Its primary advantage, from a challenger’s perspective, is that multiple prior art references may be relied upon to support the conclusion that the claim is invalid.⁵² Thus even if the claimed invention cannot be found in any single prior art reference, the claim may still be invalid because it would have been obvious in light of all the prior art that existed at the time of the invention.⁵³

As with cases of anticipation, the incentivizing effect of enforcing the obviousness doctrine depends greatly on the prior art behind the legal conclusion. In some cases, obviousness may be a tool for handling near-miss cases of anticipation, causing the value of enforcing both doctrines to closely track each other. For example, filing a claim on a trivial derivative of something that has long been in the public domain should be discouraged for the same reason that filing a claim on *exactly* what has long been in the public domain should be discouraged: the inventor should have known that the invention was already available to the public and not wasted everyone’s time

47 See *Bruckelmyer v. Ground Heaters, Inc.*, 453 F.3d 1352, 1353 (Fed. Cir. 2006) (Newman, J., dissenting from denial of the petition for rehearing en banc).

48 See Yelderman, *Value of Accuracy*, *supra* note 12, at 1272–76.

49 See 35 U.S.C. § 103 (2012).

50 *Bonito Boats, Inc. v. Thunder Craft Boats, Inc.*, 489 U.S. 141, 150 (1989).

51 *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 415 (2007).

52 See *id.* at 417.

53 See *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966). Under the AIA, the question is whether it would have been obvious at the time of filing, not invention. See 35 U.S.C. § 103.

by seeking patent protection for it.⁵⁴ Likewise, seeking subsequent protection for simplistic variants of one's own prior inventions (also known as "patent evergreening") is a wasteful, unproductive activity that patent law seeks to discourage.⁵⁵

But obviousness also extends to combinations of things that fall well beyond widespread knowledge or the inventor's own prior work. All of the obscure or secret references that qualify as prior art for purposes of anticipation qualify as prior art for purposes of obviousness, too.⁵⁶ And the risk of nonincentivizing error correction is even greater when an obscure reference is the basis for obviousness. For example, if there is little incentivizing benefit in revoking a patent solely on account of an unpublished piece of paper sitting in Canada,⁵⁷ the benefit is even smaller when it comes to revoking a patent because that Canadian document could have been combined with some *other* information found in a different (perhaps equally obscure) location.⁵⁸ So as with anticipation, the incentivizing power of revoking an obvious patent depends on the availability of the prior art that renders the patent obvious.⁵⁹

As a result, the nature of the prior art invalidating patents in district court can shed light on the public benefits of patent litigation. But to be clear, our ability to reach firm conclusions will be asymmetric depending on what the district court evidence reveals. When a district court invalidates a patent based on prior art that was widely known and easily accessible, we can identify that as an inventor-incentivizing form of error correction. But the contrapositive does not hold. When a district court invalidates a patent based on obscure prior art, we cannot rule out the possibility that the same information may have been contained in other, more widely disseminated

54 See Timothy R. Holbrook, *Patent Anticipation and Obviousness as Possession*, 65 EMORY L.J. 987, 1027–29 (2016).

55 See Dmitry Karshedt, *The More Things Change: Improvement Patents, Drug Modifications, and the FDA*, 104 IOWA L. REV. 1129, 1141 n.64, 1159–63 (2019).

56 See *Hazeltine Research, Inc. v. Brenner*, 382 U.S. 252, 252–54, 256 (1965).

57 See *Bruckelmyer v. Ground Heaters, Inc.*, 453 F.3d 1352, 1353 (Fed. Cir. 2006) (Newman, J., dissenting from denial of the petition for rehearing en banc).

58 As others have noted, the doctrine's "person of ordinary skill" comes programmed with a superhuman amount of knowledge, which can result in an unrealistic standard of invention when obscure prior art is at issue. See Daralyn J. Durie & Mark A. Lemley, *A Realistic Approach to the Obviousness of Inventions*, 50 WM. & MARY L. REV. 989, 1001, 1016 (2008); Michael Ebert, *Superperson and the Prior Art*, 67 J. PAT. & TRADEMARK OFF. SOC'Y 657, 657–59 (1985).

59 To be clear, the fact that expansive prior art rules sometimes cause inventors to lose patents for reasons beyond their control does not mean the rules themselves are substantively flawed. Even when prior art is obscure, it may be that the costs of conferring exclusive rights are unjustified in light of that prior art. Indeed, entire patentability doctrines may be justified out of concerns for ex post costs. For example, the Supreme Court has rooted the patentable subject matter requirement exclusively in concerns about costs; revocations on these grounds are *not* intended to discourage future inventors from exploring abstract ideas or natural phenomena. Yelderman, *Value of Accuracy*, *supra* note 12, at 1270–72.

sources. In such a case, we can observe that the invalidation lacks the indicia of inventor-incentivizing error correction, but we cannot necessarily conclude that the invalidation has no inventor-incentivizing effect at all.

Moreover, we must also remember that we are only exploring one way that patent litigation can benefit the public. Even cases that demonstrably provide no inventor-incentivizing error correction could provide *other* kinds of public benefits. So even if we could show that certain kinds of litigation have no inventor-incentivizing effect at all, that would not necessarily mean that current policies to encourage patent challenges are misguided. It would only mean that this particular theory cannot do all the work.

B. *Prior Work*

Courts and commentators today have the benefit of a large body of empirical patent scholarship on which to draw. No prior study, however, has examined the work of district courts at the level of detail necessary to answer the questions introduced above.⁶⁰

The vast majority of prior studies of patent cases have focused on court outcomes without reporting the factual bases for those decisions. A pair of recent articles by John Allison, Mark Lemley, and David Schwartz illustrate the current state of the art. Allison and his coauthors collected all patent cases filed between 2008 and 2009 that resulted in a substantive decision and coded those outcomes on a number of metrics, including the statutory provision that served as the basis for any invalidity decisions.⁶¹ They did not, however, report any information about the prior art supporting those decisions. As a result, one can learn how many patents were invalidated in reliance on prior art during their study period—seventy-two were anticipated and seventy-two were held to be obvious—but one cannot glean anything about the sources of the prior art the court relied on to reach those conclusions.⁶²

Earlier work by two of those coauthors did shed a bit more light on the prior art relied upon in district court, though, again, with insufficient detail

60 For an excellent synopsis of prior empirical studies in this area, see Ronald Mann & Christopher Cotropia, *Empirical Studies in Patentability*, in 2 RESEARCH HANDBOOK ON THE ECONOMICS OF INTELLECTUAL PROPERTY LAW 281 (Peter S. Menell & David L. Schwartz eds., 2019).

61 See John R. Allison, Mark A. Lemley & David L. Schwartz, *Our Divided Patent System*, 82 U. CHI. L. REV. 1073, 1080, 1083 (2015) [hereinafter Allison et al., *Divided Patent System*]; Allison et al., *Realities of Modern Patent Litigation*, *supra* note 16, at 1773, 1775–76.

62 See Allison et al., *Divided Patent System*, *supra* note 61, at 1104–05. A 2015 paper by Shine Tu likewise reports the legal basis for approximately 600 patent invalidations occurring in cases that terminated between 2010 and 2012. Shine Tu, *Invalidated Patents and Associated Patent Examiners*, 18 VAND. J. ENT. & TECH. L. 135, 143–44, 160 (2015). Along similar lines, a 2015 paper by Michael Risch provides data on the legal basis for invalidity for 73 litigated patents. Michael Risch, *A Generation of Patent Litigation*, 52 SAN DIEGO L. REV. 67, 114 tbl.13 (2015). For invalidation based on § 102(b), Risch does break out activity prior art versus printed publications. *Id.* However, the number of observations is very small—only 19 patent-level invalidity events—and this breakdown is not provided for other statutory provisions. *Id.*

to answer the questions of present interest. A 1998 paper by Allison and Lemley collected all final written validity decisions reported in U.S. Patent Quarterly between 1989 and 1996, obtaining data relating to 138 patents invalidated during their study period.⁶³ Although Allison and Lemley did not describe the sources of the prior art in detail,⁶⁴ they did observe whether the invalidation was made “primarily” based on art that had been at the examination stage.⁶⁵ With weak statistical confidence, they reported that prior art that had *not* been cited in examination was more likely to invalidate a patent than prior art that *had* been cited.⁶⁶ Along similar lines, a now-quite-dated study by Gloria Koenig sampled 150 patent invalidity decisions from 1953 to 1967 and reported the percentage of those decisions that relied on any uncited prior art.⁶⁷

Other studies have also examined the legal basis for patent invalidity determinations. For example, a 2012 paper by Ronald Mann and Marian Underweiser collected Federal Circuit patent validity decisions handed down from 2003 to 2009 and coded them based on whether the issue was one of prior art, patent drafting (such as lack of enablement or definiteness),⁶⁸ or prior use.⁶⁹ Similarly, in a 1995 article, Donald Dunner, J. Michael Jakes, and Jeffrey Karciski collected Federal Circuit validity decisions from 1982 to 1994 and reported their disposition by legal bases, though they did not explore the prior art that led to those decisions.⁷⁰ Another set of studies reported litigation success rates for patent holders but did not report even the legal basis for invalidity determinations, much less the prior art at issue.⁷¹

63 John R. Allison & Mark A. Lemley, *Empirical Evidence on the Validity of Litigated Patents*, 26 AIPLA Q.J. 185, 187, 205 (1998).

64 Allison and Lemley did break out § 102 invalidations into two subcategories. They found that approximately 46% of § 102 invalidations were based on “true” prior art, while approximately 54% of § 102 invalidations involved the inventor’s forfeiting patentability through his own actions (often called statutory bars), abandoning the invention § 102(c), deriving the invention from another under § 102(f), or losing a priority dispute under § 102(g). *Id.* at 199 n.39, 208. This classification provides a bit more information about the underlying invalidity decision, but still does not reveal what the invalidating prior art actually was.

65 *See id.* at 229–33.

66 *Id.* at 233–34.

67 *See* GLORIA K. KOENIG, PATENT INVALIDITY 5-2, 5-48 (rev. ed. 1980).

68 *See* 35 U.S.C. § 112 (2012).

69 Ronald J. Mann & Marian Underweiser, *A New Look at Patent Quality: Relating Patent Prosecution to Validity*, 9 J. EMPIRICAL LEGAL STUD. 1, 7 (2012). Unfortunately for present purposes, the authors did not report the number of patents invalidated based on prior art versus prior use.

70 Donald R. Dunner, J. Michael Jakes & Jeffrey D. Karciski, *A Statistical Look at the Federal Circuit’s Patent Decisions: 1982–1994*, 5 FED. CIR. B.J. 151, 153, 158 (1995).

71 *See, e.g.*, Jay P. Kesan & Gwendolyn G. Ball, *How Are Patent Cases Resolved? An Empirical Examination of the Adjudication and Settlement of Patent Disputes*, 84 WASH. U. L. REV. 237, 276 tbl.8 (2006) (reporting 118 invalidity events for all patent cases filed in 1995, 1997, and 2000, but without disclosing legal basis or prior art); Mark A. Lemley, *An Empirical Study of the Twenty-Year Patent Term*, 22 AIPLA Q.J. 369, 418–21 (1994) (reporting success rates of

A number of papers have focused on the obviousness inquiry in particular, usually with an interest in exploring whether and how the obviousness standard may have changed over time. For example, a 2006 paper by Sean McEldowney collected published district court opinions from 1970 through 1975 and 1995 through 2000 to assess whether obviousness challenges had become more or less likely to succeed after the creation of the Federal Circuit.⁷² Along similar lines, a 2001 paper by Glynn Lunney collected appellate opinions from various time periods over a fifty-year span to measure shifts in the frequency of obviousness-based invalidity.⁷³ Another series of papers have investigated how the Federal Circuit's approach to obviousness has changed after the Supreme Court's decision in *KSR International Co. v. Teleflex Inc.*⁷⁴ All of these studies were focused on the outcome or methodology of the obviousness determination; none of them explored the prior art underlying that determination.⁷⁵

In sum, then, prior work provides some reference points about the number of patents invalidated each year and the percentage of challenges that

patent challenges); Kimberly A. Moore, *Forum Shopping in Patent Cases: Does Geographic Choice Affect Innovation?*, 79 N.C. L. REV. 889, 918–19 (2001) (evaluating success rate of challenges to patent validity based on judicial district); Kimberly A. Moore, *Judges, Juries, and Patent Cases—An Empirical Peek Inside the Black Box*, 99 MICH. L. REV. 365, 390–92 (2000) (reporting similar statistics, evaluated based on factfinder rather than venue). For a much older study of the legal bases of patent invalidity, see P.J. Federico, *Adjudicated Patents, 1948–54*, 38 J. PAT. OFF. SOC'Y 233 (1956).

72 Sean M. McEldowney, Note, *New Insights on the “Death” of Obviousness: An Empirical Study of District Court Obviousness Opinions*, 2006 STAN. TECH. L. REV. 4, ¶¶ 22, 29–34.

73 Glynn S. Lunney, Jr., *E-Obviousness*, 7 MICH. TELECOMM. & TECH. L. REV. 363, 370–75 (2001).

74 550 U.S. 398 (2007); see Ali Mojibi, *An Empirical Study of the Effect of KSR v. Teleflex on the Federal Circuit's Patent Validity Jurisprudence*, 20 ALB. L.J. SCI. & TECH. 559, 561 (2010); Jennifer Nock & Sreekar Gadde, *Raising the Bar for Nonobviousness: An Empirical Study of Federal Circuit Case Law Following KSR*, 20 FED. CIR. B.J. 369, 371 (2011); Jason Rantanen, *The Federal Circuit's New Obviousness Jurisprudence: An Empirical Study*, 16 STAN. TECH. L. REV. 709, 711 (2013); see also Christopher A. Cotropia, *Nonobviousness and the Federal Circuit: An Empirical Analysis of Recent Case Law*, 82 NOTRE DAME L. REV. 911, 913–14, 927 (2007) (studying how the Federal Circuit approached obviousness in the years prior to *KSR*); Lee Petherbridge & R. Polk Wagner, *The Federal Circuit and Patentability: An Empirical Assessment of the Law of Obviousness*, 85 TEX. L. REV. 2051, 2071–72 (2007) (same). For other studies of obviousness outcomes in various tribunals, see Gregory N. Mandel, *A Nonobvious Comparison: Nonobviousness Decisions at the PTAB and in the Federal Courts*, 24 TEX. INTELL. PROP. L.J. 403 (2016).

75 Several of the papers cited above hint at steps taken to collect or code information about cited prior art. See Allison et al., *Divided Patent System*, *supra* note 61, at 1083 (“We also coded various bases for § 102 invalidity.”); Allison et al., *Realities of Modern Patent Litigation*, *supra* note 16, at 1776 (“We also coded various bases for section 102 invalidity.”); Nock & Gadde, *supra* note 74, at 389 (“If prior art was discussed, the type of prior art was coded as patents, non-patent publications, witness testimony, or products.”); Petherbridge & Wagner, *supra* note 74, at 2073. Unfortunately, none of these studies report the results of this coding.

were successful. But no prior study has provided a comprehensive picture of the prior art underlying those district court decisions.⁷⁶

II. METHODOLOGY

To shed light on the questions set forth above, we undertook a straightforward but substantial task: examining every district court patent decision over a six-and-a-half-year period and identifying the prior art underlying each invalidity determination. Section A describes our methodology for collecting and coding these documents. Section B then addresses several potential questions about reproducibility and selection effects.

A. Collection and Coding

Collecting and analyzing invalidity in the district court involved three basic steps. First, we collected the primary source documents (court opinions and verdict forms) in which invalidity occurred. Second, we reviewed these documents to determine the legal basis and prior art supporting the court's decision. Third, we gathered contextualizing information about the case, patent, and cited prior art from a number of secondary sources.

To obtain all district court invalidity rulings that occurred during the study period, we ran a special query search on Docket Navigator⁷⁷ for every determination of invalidity between January 1, 2011, and June 30, 2017.⁷⁸ This initial query returned 2601 documents. We then reviewed each of these documents to determine whether it was (1) a district court⁷⁹ opinion or jury verdict; (2) in which one or more claims of a utility patent were determined to be invalid; and (3) not identical to another document we had already collected. Applying these criteria produced a set of 820 opinions and 85 jury verdicts, for a total of 905 documents.

For each document in this set, we captured basic caption information and coded the legal determinations of invalidity contained in that document. For all bases of invalidity, we recorded the legal grounds and patent number

⁷⁶ By contrast, several papers have explored the nature of the prior art used in *examination*. See, e.g., Christopher A. Cotropia, Mark A. Lemley & Bhaven Sampat, *Do Applicant Patent Citations Matter?*, 42 RES. POL'Y 844, 844 (2013); Dennis D. Crouch, *Is Novelty Obsolete? Chronicling the Irrelevance of the Invention Date in U.S. Patent Law*, 16 MICH. TELECOMM. & TECH. L. REV. 53, 66 (2009).

⁷⁷ Docket Navigator is a commercial database service that has collected every decisional document directly from district court dockets for certain categories of cases, including patent cases. See DOCKET NAVIGATOR, <http://brochure.docketnavigator.com/> (last visited Oct. 21, 2019). The company offers no-cost subscriptions to academic researchers and very graciously assisted the current project by answering many questions.

⁷⁸ We selected this particular study period to obtain the most recent data possible, while also ensuring we had several hundred invalidations on both anticipation and obviousness grounds.

⁷⁹ At this step we included all opinions by magistrate judges and special masters. We also included decisions in the Court of Federal Claims as if it were a federal district court. We excluded decisions by the International Trade Commission.

of the affected patent. When a patent was invalidated for anticipation or obviousness, we also coded the court's conclusions at a claim level, identifying the reference (or references) supporting the invalidity decision. Redundant rationales for claim invalidity were coded as distinct invalidity events. For example, if the court found the same claim both anticipated and obvious, we recorded one observation for the anticipation conclusion and another observation for the obviousness conclusion. Likewise, if the court found the same claim anticipated by two distinct references, we recorded one observation for anticipation based on the first reference and another observation for anticipation based on the second reference. We recorded only conclusions that a claim was invalid; there are no failed validity challenges in our dataset.

For judicial decisions of invalidity (motions to dismiss, summary judgment, judgment as a matter of law, and bench trials), this coding process was straightforward. Jury verdicts were a bit more complicated, since verdict forms do not always interrogate the factual basis for the jury's conclusions. We addressed this potential ambiguity by first coding all the information that we could glean from the jury verdict form itself and then consulting the post-trial docket and appellate filings to fill in as much additional information as possible. In many cases, a later ruling by the judge denying judgment as a matter of law clearly identified the prior art that (in the judge's view) provided an adequate evidentiary basis for the jury's finding. If we could not unambiguously discern the jury's legal conclusions, we coded the cited prior art (and sometimes, legal basis) as "unknown." In a few cases, the verdict form or post-trial activity made it clear that the basis for the decision was either anticipation or obviousness but did not unambiguously specify which. In these cases, we coded the legal basis as "102 or 103 (unknown)."

After using this procedure to code all the documents in the set, we then checked for redundancy across the docket of a particular case. Because a court will sometimes make multiple decisions that effectively affirm the same result, it was possible that the same invalidity event could have been redundantly coded. For example, when a magistrate judge recommended granting summary judgment and the district judge adopted that recommendation, our initial coding would have recorded the same ruling twice: first based on the magistrate's recommendation, and then a second time based on the district judge's adoption of that recommendation. At the level of the court's docket these might appear to be multiple invalidations, but they are not legally distinct invalidation events.

To avoid this potential double counting, we identified cases with multiple coded documents and checked for decision-level redundancy. When we found decision-level redundancy—defined as the same substantive ruling being captured in multiple documents—we dropped the redundant observations, keeping only one observation of that ruling using an "earliest undisturbed decision" rule. For example, if the district court judge adopted a magistrate's invalidity ruling in full, we dropped the district judge's opinion and preserved the magistrate opinion as the earliest undisturbed ruling. However, if the district judge modified the magistrate judge's invalidity rul-

ing in some way, rejecting the earlier ruling or adopting it only in part, the district judge's opinion became the operative observation and the magistrate opinion was dropped. We applied the same rule for motions for reconsideration, amended opinions, and corrected jury verdict forms.⁸⁰ Our coding was based exclusively on the decisions of district courts; we did not observe the outcomes of appeals.⁸¹

After collecting, coding, and dropping redundant observations in the manner described above, our dataset contained 1542 patent-level invalidity events.⁸² The legal bases and procedural postures of these patent-level invalidity events broke down as follows:

80 To be clear, we applied this “earliest undisturbed decision” rule only at the level of the district court docket—we did not drop or replace district court decisions based on the results of appeal. As a result, if a district court invalidated a claim, the Federal Circuit reversed and remanded, and the district court invalidated that claim again, both district court decisions would appear in the dataset. We observed this on fewer than five occasions.

81 As a result, it is likely that at least a few of the invalidations in our dataset were later reversed on appeal. Conversely, there are likely some cases in which the district court did not find a particular claim invalid, but the Federal Circuit did so on appeal. These invalidations events would be absent from our dataset. Finally, there may have been some cases in which the district court found a claim invalid based on one legal basis/reference and the Federal Circuit affirmed on a *different* legal basis (or reference). In these cases, our data would reflect the legal basis/reference combination relied upon by the district court. We chose to focus on the work of the district court because (a) doing so permits us to study more recent invalidation events (appeals and retrials can drag on for years), and (b) a district court determination of invalidity is often a legally and economically significant event in its own right, even if it is later reversed or modified on appeal. We cannot predict how our results would change if instead of focusing on district courts we traced the path of patents up and down through appeals.

82 Each patent-level invalidity event represents a unique combination of decisional document, patent, and legal basis. Thus, the same patent experiencing invalidity on the same legal basis in two different court documents would correspond to two distinct invalidity events. Likewise, the same patent experiencing invalidity on two different legal bases in a single court document would correspond to two distinct invalidity events.

TABLE 1: PATENT-LEVEL INVALIDITY EVENTS, BY LEGAL BASIS AND POSTURE

Posture / Legal Basis	Pleading Stage	Summary J. / <i>Markman</i>	Jury Verdict	Bench Trial	Posttrial	Total
§ 101	360	147	1	0	1	509
Anticipation	0	138	73	12	7	230
Obviousness	0	95	85	56	13	249
Anticipation or Obviousness (indeterminate)	0	0	12	0	0	12
Indefinite	3	344	0	8	2	357
Enablement	0	28	7	6	2	43
Written Description	0	42	12	4	1	59
Unknown	0	0	8	0	0	8
Other	5	48	12	9	1	75*
Total	368	842	210	95	27	1542

Note: *The legal bases of the 75 “other” patent-level invalidity events consist of issue preclusion / estoppel (24); improper inventorship / 35 U.S.C. § 102(f) (2006) (17); impermissible rebroadening under 35 U.S.C. § 251 (2012) or 35 U.S.C. § 305 (2012) (8); nonstatutory double-patenting (7); lack of utility (6); failure to disclose best mode (5); inequitable conduct (4); failure to otherwise comply with 35 U.S.C. § 112 (2012) (4).

To be clear, some patents were invalidated on multiple grounds or in multiple decisional documents. These 1542 patent-level invalidity events involved 1273 distinct patents. Overwhelmingly, the redundancy came from multiple invalidations of a patent within the same court. Only 26 patents experienced invalidity in multiple courts during the study period.⁸³

For the 499 of these patent-level invalidity events based on anticipation, obviousness, or an unknown legal basis, we also coded at the level of individual claims. These yielded 3320 claim-level invalidity events affecting 390 distinct patents.⁸⁴ We were able to determine the prior art relied upon for 91% of these invalidations, resulting in 3036 claim-level invalidity events based on 817 distinct, identifiable prior art references.

The final step of our coding process was to gather contextualizing information about the patents, cases, and prior art references from a number of secondary sources. Some of this additional research was necessary to fill in information that would normally be expected in the court’s opinion but that was missing in individual cases. For example, in some instances, it was not possible to unambiguously identify a patent number, claim number, or prior

83 Among these, only two patents were invalidated on prior art grounds by multiple district courts—and in these instances each court invalidated a different set of claims.

84 Each claim-level invalidity event represents a unique combination of decisional document, patent, claim, legal basis, and prior art reference set.

art reference from the face of the primary document alone.⁸⁵ When this occurred, we variously referred to party briefs, pretrial orders, and final judgments to disambiguate the verdict or opinion. On a few occasions, pulling these supplementary court documents revealed apparent errors in the original opinion we coded—such as flipped digits in a patent number or misspelling of a reference name. Resolving these conflicts required further investigation of the court’s docket entries.

Other supplementary research tasks drew from a number of secondary sources. For example, we consulted U.S. Patent and Trademark Office (PTO) databases to collect a number of data points relating to filing date, prosecution history, and priority claims.⁸⁶ We also consulted another commercial database service, Lex Machina,⁸⁷ to collect additional information about the litigation that gave rise to the court opinion or verdict.

B. Reproducibility and Selection Effects

Though time intensive, the methodology described above is highly reproducible. With one exception discussed below, all of the coding and collection steps can be fairly described as rote data entry based on publicly available sources.

Our choice to code invalidity events at the level of individual claims is an essential feature in this regard. Because a single opinion may reach different conclusions for different claims, or invalidate the same claim for multiple reasons, coding at a higher level of granularity would necessarily require subjective judgments about which aspects of the court’s opinion were the most

85 For example, short opinions and jury verdicts often refer to prior art references only by the author’s name (“the Smith reference”) and refer to litigated patents only by the last three digits of their patent number (“the 091 Patent”).

86 In particular, at various steps of this project we employed the PTO’s Public Pair Research Dataset, the PTO’s Assignment Database, and the PTO’s Historical Patent Data Files. *Electronic Patent Application Submission and Retrieval*, U.S. PAT. & TRADEMARK OFF., <https://www.uspto.gov/learning-and-resources/newsletter/inventors-eye/electronic-patent-application-submission-and-retrieval> (last visited Oct. 27, 2019); *Historical Patent Data Files*, U.S. PAT. & TRADEMARK OFF., <https://www.uspto.gov/learning-and-resources/electronic-data-products/historical-patent-data-files> (last visited Oct. 27, 2019); *Patent Assignment Search*, U.S. PAT. & TRADEMARK OFF., <https://assignment.uspto.gov/patent/index.html#/patent/search> (last visited Oct. 27, 2019). See generally Stuart Graham et al., *The USPTO Patent Examination Research Dataset: A Window on the Process of Patent Examination* (U.S. Patent & Trademark Office, Economic Working Paper No. 2015-4, 2015), <https://ssrn.com/abstract=2702637> (describing the Patent Examination Research Dataset from PAIR); Alan C. Marco et al., *The USPTO Historical Patent Data Files: Two Centuries of Innovation* (U.S. Patent & Trademark Office, Economic Working Paper No. 2015-1, 2015), <http://ssrn.com/abstract=2616724> (describing the Historical Patent Files).

87 LEX MACHINA, <https://lexmachina.com/> (last visited Oct. 20, 2019). Lex Machina also graciously provided no-cost subscriptions to support our work.

significant.⁸⁸ We avoided making subjective judgments by simply coding everything.

The one aspect of our coding process that sometimes involved a measure of interpretive judgment was the step of identifying the prior art relied upon to find a claim obvious. Obviousness is a complex, multifaceted determination, and sometimes turns on evidence that is not, strictly speaking, prior art at all.⁸⁹ In coding obviousness determinations, we attempted to identify the prior art references that were explicitly relied upon to form the *prima facie* case of obviousness and to exclude references cited only for technical background, motivation to combine, or secondary considerations of nonobviousness.⁹⁰

Many court documents clearly identified the specific prior art references that formed the basis for concluding that a claim was obvious.⁹¹ In these cases, coding the prior art relied upon for obviousness was a straightforward process of data entry, much like the other aspects of our coding as described above. But there were also cases in which the court's obviousness discussion was surprisingly opaque, making it difficult to discern which prior art references had been relied upon to invalidate exactly which claims. In these cases, mapping prior art to claims sometimes required a few judgment calls.

To test the reproducibility of our obviousness coding, we asked an experienced patent attorney with no other connection to this project to independently code a subset of the obviousness events. Her interpretation of the claims that had been held obvious was consistent with our initial coding in 99% of claim-level obviousness events, and her interpretation of the prior art relied upon to support those invalidations was consistent with our initial coding in 91% of claim-level obviousness events.⁹² Within the 9% of claim-level obviousness events in which our interpretations differed, there were some cases in which both coders agreed about the prior art references supporting obviousness at a patent level but had simply mapped those references to claims in a slightly different manner. In these cases, our differing interpretation of the source opinion would have a subtle effect on the weighting of certain pieces of prior art but would not bring in (or exclude) actually differ-

88 Cf. Allison & Lemley, *supra* note 63, at 232 n.87 (describing "difficult judgment[s]" in determining which references were "primarily" relied upon by the courts).

89 See *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

90 See *id.* (distinguishing these steps).

91 The familiar form of this statement goes something like, "For the reasons stated above, it would have been obvious to combine Reference A with Reference B in light of Reference C to arrive at the invention of Claim 1."

92 Specifically, we used a random number generator to draw twenty court opinions that we had previously coded as containing one or more obviousness invalidity events and asked the secondary coder to indicate which references the court had relied upon to invalidate each claim. Of the 180 claim-level obviousness events in those opinions, the primary and secondary coder identified the same set of references in 164 of them. The primary coder identified one or more references not identified by the secondary coder for 12 claim-level invalidity events. In the opposite direction, the secondary coder identified one or more references not identified by the primary coder for 4 claim-level invalidity events.

ent references.⁹³ Ultimately, we cannot say for sure whether the need to interpret some obviousness opinions may have biased our results, and, if so, in which direction that bias would have pointed. However, the high percentage of agreement between coders suggests that the magnitude of any bias would be small.

Finally, a quick word about selection effects. Our population of interest is district court decisions, which we have observed directly from the underlying court documents. This dataset allows us to report a number of things about how and why patents are invalidated in district court. It does not, however, permit us to make inferences about patent quality more generally. Only a very small fraction of issued patents are ever asserted in court, and, of those, only a very small fraction are litigated to the point of a validity determination. And the decisions to assert, settle, or litigate might well turn on the variables of interest to our study.

To illustrate, suppose that a very small percentage of our observed district court invalidations rely on foreign patents. From this fact, it may be tempting to conclude that very few of the millions of U.S. patents in circulation are invalid based on foreign patents and perhaps even to discourage the PTO from searching foreign patents.⁹⁴ This inference, however, would be unsupported. It could be the case that millions of U.S. patents *are* invalid as a result of foreign patents but that litigants typically settle these cases before the court can reach a decision on the merits. Or, conversely, it is possible that litigants never settle such cases. Observed litigation outcomes could either understate or overstate the importance of a prior art category in terms of patent quality overall. Therefore, this data should only be used to answer questions about why patents are invalidated in district court, not why patents might be invalid in general.

Note, however, that for purposes of assessing the public benefits of patent litigation, these selection effects are a feature, not a bug. In fact, they are the point. If litigants typically settle cases involving a particular kind of prior art, that tendency directly affects the value of the cases that *are* litigated to a decision and should be taken into account when measuring the benefits of encouraging patent cases. And if by chance there are no selection effects—if patents reaching a reasoned decision *are* representative of patents overall—then the same point stands. Understanding the factual bases of these decisions directly informs whether the cost of that error correction was worth the investment.

93 Generally speaking, more sophisticated metrics for measuring intercoder reliability (such as Cohen's kappa coefficient) are preferable to percentage of agreement, because they take into account the possibility of agreement occurring by chance. However, these metrics are inappropriate for the coding at issue here, since the set of potential responses is open ended.

94 See Dennis Crouch, *How Many US Patents Are In-Force?*, PATENTLY-O (May 4, 2012), <https://patentlyo.com/patent/2012/05/how-many-us-patents-are-in-force.html> (estimating, in 2012, that 2.1 million U.S. patents were currently in force).

III. PRIOR ART IN THE DISTRICT COURT

There are three basic facts relevant to the value of the error correction provided by district courts. First, are courts invalidating claims based on anticipation or obviousness? Second, how obscure is the prior art that provides the basis for the invalidity ruling? Third, was there some relationship between one of the parties and the invalidating prior art at issue?

This Part reports the results of our study with an eye to answering these questions.

A. *Anticipation vs. Obviousness*

Based on the differences between the anticipation and obviousness inquiries, one might expect obviousness to dominate the work of district courts. Obviousness is a complex question of law, one that is generally thought to be less predictable. Anticipation, on the other hand, is usually regarded as a straightforward factual determination. Because parties are more likely to settle cases with clearer outcomes and to litigate cases with less predictable outcomes,⁹⁵ one might predict obviousness to represent an outsize portion of the work of district courts in patent cases.

This prediction would be wrong. Over the course of the study period, the number of claims invalidated on anticipation grounds (1636) almost exactly equaled the number of claims invalidated on obviousness grounds (1620).⁹⁶ Moreover, the relationship between anticipation and obviousness appeared stable throughout the study period:

⁹⁵ See generally George L. Priest & Benjamin Klein, *The Selection of Disputes for Litigation*, 13 J. LEGAL STUD. 1 (1984).

⁹⁶ In addition, 19 claims were held invalid on legal grounds that were not stated by the court. Another 45 claims were invalidated either for anticipation or obviousness, though we could not conclusively determine which argument carried the day. These 2% of claims with an ambiguous legal basis are excluded in the following discussion.

FIGURE 1: RATIO OF ANTICIPATION EVENTS TO OBVIOUSNESS EVENTS

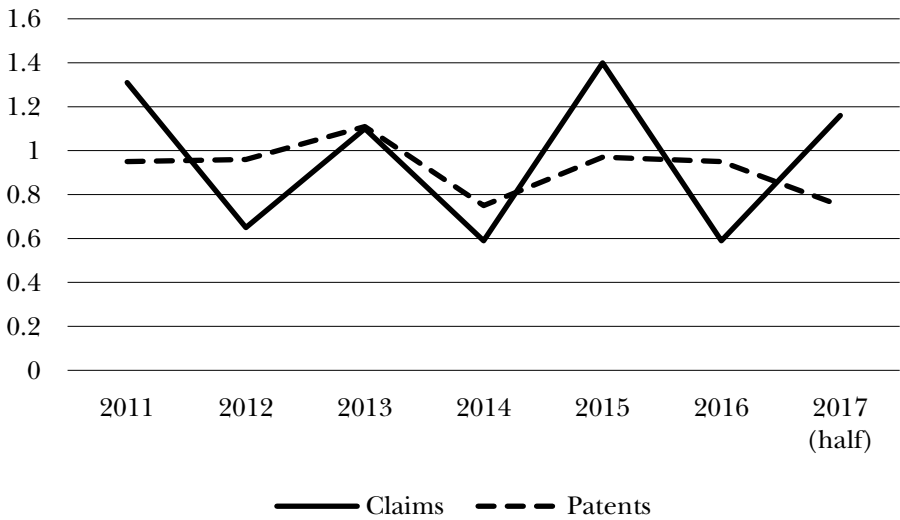


Figure 1 illustrates the ratio of anticipation events to obviousness events—a result above 1 means anticipation events dominated obviousness events, while a result below 1 means obviousness events dominated anticipation events. Although there was some variation year to year, the ratio hung very close to 1:1, whether counted in terms of invalidated patents or invalidated claims.

At a patent level, this result is consistent with prior studies, which reported a similar balance between anticipation and obviousness decisions in district court.⁹⁷ In fact, the fifty-fifty split of patent-level invalidity events appears to have held constant for over two decades.⁹⁸ No prior study has reported this data at the level of individual claims, but it appears the balance is roughly even at a claim level as well.

97 For example, Allison et al.'s 2014 paper reported 31 successful motions for summary judgment on the basis of anticipation and 31 successful motions for summary judgment on the basis of obviousness. See Allison et al., *Realities of Modern Patent Litigation*, *supra* note 16, at 1785 tbl.2; see also Allison et al., *Divided Patent System*, *supra* note 61, at 1104–05. But see Tu, *supra* note 62, at 159 (reporting that anticipation and obviousness respectively accounted for 21.5% and 35.4% of all district court invalidations).

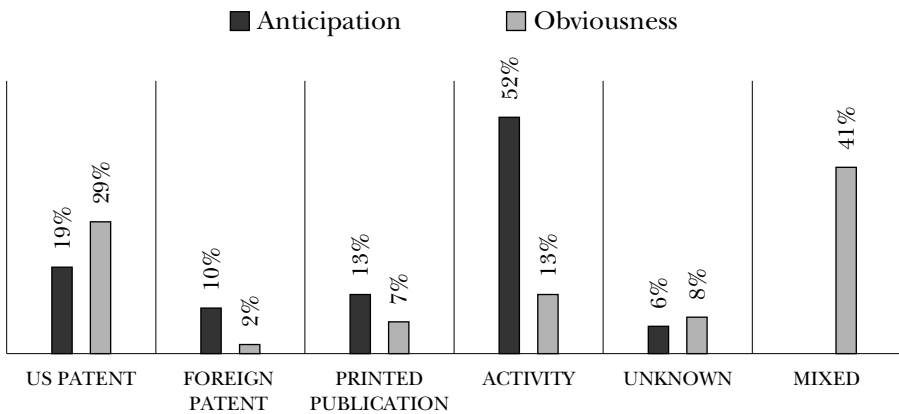
98 See Allison & Lemley, *supra* note 63, at 208 tbl.1 (1998 study of reported decisions found 42% of invalidations relied on obviousness). In studies of *appellate* decisions, Glynn Lunney found that the percentage of cases relying on obviousness declined between the mid-1980s and mid-1990s. See Lunney, *supra* note 73, at 373; Glynn S. Lunney, Jr., *Patent Law, the Federal Circuit, and the Supreme Court: A Quiet Revolution*, 11 SUP. CT. ECON. REV. 1, 14–15 (2003). However, these studies included all grounds of invalidity (not simply anticipation and obviousness), and because of selection effects may not be representative of the work of district courts during that time period.

B. *Categories of Prior Art*

A primary focus of our study was the prior art relied upon by courts when finding claims to be either anticipated or obvious. This Section introduces the top-level picture of that prior art; subsequent Sections explore subcategories of prior art in more detail.

At the highest level, we classified invalidating prior art into four categories: U.S. patents (including U.S. patent applications), foreign patents (including applications to foreign patent offices and applications filed under the Patent Cooperation Treaty), printed publications, and activities (including prior uses, sales, and invention by another).⁹⁹ Figure 2 illustrates the percentage of claim-level invalidity events relying on each category of prior art.

FIGURE 2: BASIS FOR INVALIDITY



The anticipation data is straightforward to interpret. Represented by the solid black columns, the majority of anticipation invalidations (52%) relied on prior art classified as activities. The other three categories were invoked much less frequently, ranging from 19% (U.S. patents) to 13% (printed publications) down to 10% (foreign patents).¹⁰⁰ Note that these final three categories are quite close in their comparative frequency, and the 6% of anticipation invalidations in the “unknown” category could swing their comparative significance. By contrast, the dominance of activity-based prior art for anticipation invalidations is clear.¹⁰¹

⁹⁹ See 35 U.S.C. § 102(b), (g) (2006).

¹⁰⁰ Because an anticipation ruling may rely on only one piece of prior art, the percentages atop the black columns sum to one.

¹⁰¹ Some readers may wonder whether the percentage of invalidations relying on activity prior art has changed since the advent of inter partes review (IPR). See 35 U.S.C. § 311(b) (2012). Because many patents are now invalidated in IPR, where activity-based prior art is not admissible, it seems plausible that a reverse selection effect might increase

The picture of obviousness is more complicated, as a result of the doctrine’s flexibility to rely on multiple prior art references. Overall, U.S. patents appeared to be the most important single category for obviousness invalidations, with 29% of invalidation events drawing exclusively on U.S. patent prior art. Printed publications and activities were effectively in a tie for second place: with 13% of obviousness invalidations drawing exclusively on printed publications and 7% of obviousness invalidations drawing exclusively on activity prior art, these two categories were within the margin of error resulting from the 8% of obviousness invalidations for which we could not determine the prior art. Only 2% of our observed obviousness events relied exclusively on foreign patents.

But Figure 2 reveals that the single most common kind of obviousness invalidation was none of the above. Indeed, 41% of obviousness invalidations involved “mixed” prior art—that is, the court relied on at least one reference in one category and at least one reference in a different category. Therefore, to obtain a clear picture of how courts use prior art to find claims obviousness, we have to deal with the phenomenon of cross-category combinations.

One way to do this is to consider the number of invalidations relying on *any* prior art in each category:

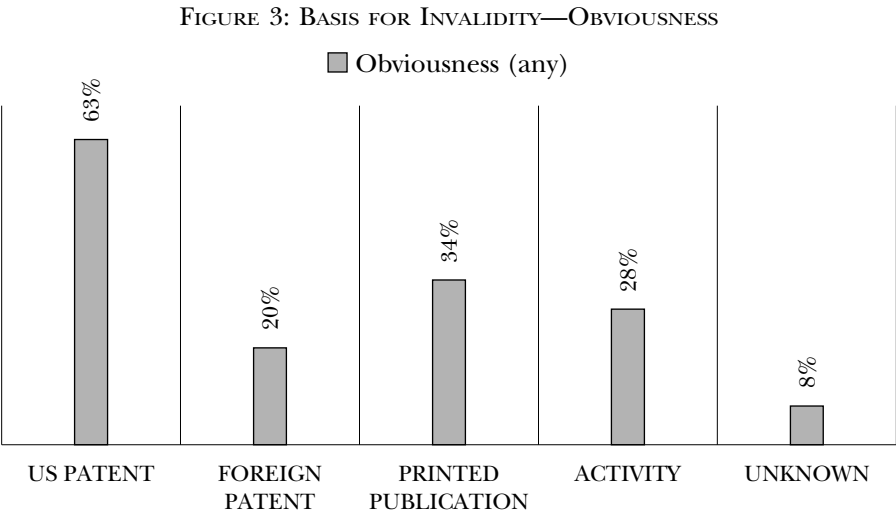


Figure 3 illustrates the number of obviousness invalidations citing any art in each category as a percentage of all obviousness invalidations. As shown above, 63% of obviousness invalidations cited at least one U.S. patent—confirming the dominance of that category as reflected in the single-category analysis of Figure 2. Printed publications and activity prior art like-

the number of district court cases involving activity prior art in the future. This possibility is explored in Section V.B.

wise remain tied for second place. With 34% of obviousness invalidations citing at least one printed publication and 28% of obviousness invalidations citing at least one activity, these two categories were within the margin of error resulting from the 8% of obviousness invalidations for which we could not determine the prior art. The most dramatic difference between Figure 2 and Figure 3 was in courts' reliance on foreign patents. Though foreign patents were almost never the exclusive basis for obviousness, they played a supporting role in about 20% of obviousness invalidations.

The columns of Figure 3 sum to more than 100% because of cross-category obviousness invalidations. An obviousness invalidation relying on references from multiple categories will appear within multiple columns, thus pushing the total above 100%.¹⁰² (The same explanation applies in several subsequent figures presenting the percentage of obviousness invalidations citing any art in a particular category.)

The following Sections will explore each of these categories in greater detail, beginning with printed publications.

C. Printed Publications

The incentivizing power of revoking a patent can vary significantly within these top-level categories. The printed publication category is perhaps the best example of this. On one extreme, an invalidation based on a printed publication can punish a fraudster who sought to claim an invention that was already widely known throughout an industry. Alternatively, a very similar invalidation could involve a piece of prior art that wasn't widely known but that a reasonably diligent search would have revealed. Or, to go to the opposite extreme, an invalidation based on a printed publication could be a case of tough luck, one in which the inventor did everything right but nonetheless was ensnared by an obscure publication neither she nor any of her peers had ever seen.¹⁰³

The incentivizing value of invalidating patents based on printed publications varies to these extremes in part because the Federal Circuit has interpreted the category so expansively. A publicly accessible document found anywhere in the world may qualify as prior art, even if it would have been extremely difficult to find at the time of invention.¹⁰⁴ Indeed, under the Federal Circuit's *Klopfenstein* test, printed publication can include things that colloquially would not be understood as "publications" at all—such as slide shows, poster boards, and handouts displayed or distributed at confer-

102 The fact that the columns in Figure 3 sum to 153% reveals that at least a few obviousness invalidations rely on art in three or four categories. As Figure 2 shows, 41% of all obviousness invalidations were in the "mixed" category. If these invalidations cited art in only two categories, Figure 3's columns would sum to 141%. The sum exceeds that because some invalidations appear in either three or four categories.

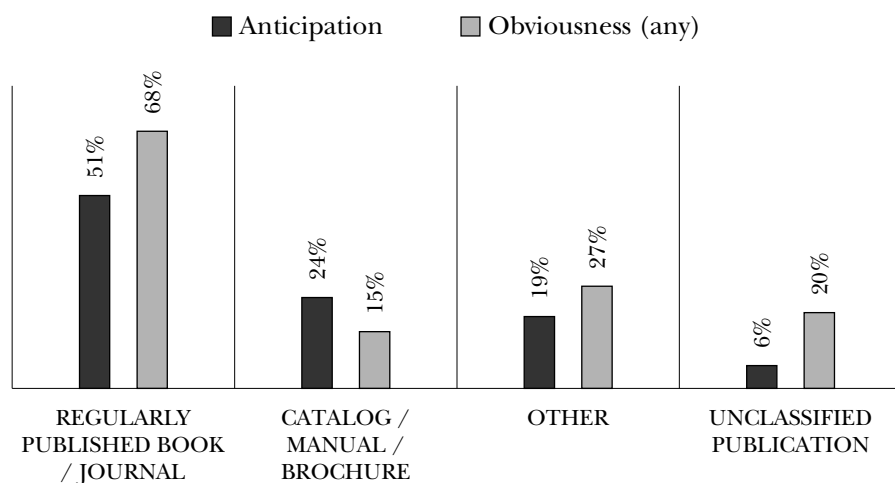
103 See Yelderman, *Value of Accuracy*, *supra* note 12, at 1272–76.

104 See *id.* at 1274–75.

ences.¹⁰⁵ This approach has been criticized,¹⁰⁶ though its effects have not been previously quantified.

To determine whether the printed publications used in court typically fit the colloquial understanding of that term or exploit the fringes of *Klopfenstein*, we classified publications into a number of subcategories. Figure 4 illustrates the percentage of claim-level invalidity events relying on each subcategory of printed publications.

FIGURE 4: BASIS FOR INVALIDITY—PRINTED PUBLICATIONS



Encouragingly, Figure 4 reveals that the majority of printed publications relied upon by district courts were conventional printed publications—that is, regularly published books and journals of the type a library might collect and an interested researcher might access.¹⁰⁷ These regularly published books and journals were behind 51% of anticipation events citing a printed publication, and were cited in 68% of obviousness invalidations relying on any publications.

By contrast, anticipation based on publications in the “other” category was surprisingly small—just 19% of anticipation events citing a printed publication. These were *Klopfenstein*-style references, documents that fail the test of being a regularly published book or journal (and that are not catalogs, manuals, or brochures, as discussed below). To provide just a few examples of publications in this “other” category, we observed prior art publications

105 See *In re Klopfenstein*, 380 F.3d 1345, 1350–52 (Fed. Cir. 2004).

106 See, e.g., Margo A. Bagley, *Academic Disclosure and Proprietary Rights: Putting Patents in Their Proper Place*, 47 B.C. L. REV. 217, 221 (2006).

107 For purposes of classification, a book was in this category if its citation included the name of a publisher (distinct from the author) and a year of publication. A journal was in this category if its citation referred to a multiple-volume periodical and a year of publication. This category also includes publicly available documentation of industry or government standards.

consisting of poster boards displayed at conferences, industry whitepapers, proposals circulated at working group meetings of technical standards bodies, doctoral dissertations, and postings on internet discussion forums. The accessibility of these various documents ranges somewhat (and, in some cases, might be debatable), but none of them can be described as a regularly published book or journal.

The good news is that publications in this “other” category were only rarely the basis for anticipation. Moreover, the category becomes even less significant when one considers that only 13% of anticipation invalidations rely on printed publications at all.¹⁰⁸ From the perspective of anticipation overall, these nontraditional publications were the basis for only 2.4% of anticipation events—a tiny fraction of the work of district courts.

Nontraditional publications were somewhat more common in cases of obviousness, but nonetheless were cited in a minority of cases. Among obviousness invalidations citing any publications, only 27% cited a publication in the “other” category. As a fraction of all obviousness invalidations, reliance on this category was rare: roughly 9% of all obviousness events cited a nontraditional publication.

However, we must note that there were also some printed publications that defied further classification. Generally, these were cases in which the court used a shorthand citation—for example, the “Jones document”—which we were unable to disambiguate. These may have been traditional publications or obscure ones; we simply cannot tell.

Fortunately, among cases of anticipation, the number of unclassified references was small enough (6%) that it could not change our conclusion that reliance on *Klopfenstein*-style publications appears to be rare. However, there were significantly more unclassifiable publications cited in cases of obviousness. If every unclassified reference turned out to belong in the “other” category (a worst-case scenario), it is possible that up to 16% of all obviousness invalidations would rely on at least one nontraditional publication.

Finally, we coded a subcategory of catalogs, manuals, and brochures—written documents distributed to teach the public about the features or availability of a product. Although not traditional reference publications, these documents are typically disseminated widely to either promote or accompany an item for sale.

These publications were not cited with great frequency. Among invalidations citing publications, 24% of anticipation events and 15% of obviousness events cited a catalog, manual, or brochure. From the perspective of invalidity overall, the numbers are smaller still—only about 3% of all anticipation events and 5% of all obviousness events cite any documents in this category. But despite its infrequent appearance in court, this category is at least conceptually important, as it is something of a chimera. While legally these references are qualifying as prior art under the “publication” gate, from the perspective of a hypothetical art searcher they have more in com-

108 See *supra* Figure 2.

mon with activity prior art. (Libraries, after all, do not typically maintain collections of product manuals, brochures, and catalogs.)¹⁰⁹ Moreover, in practice, these publications are often introduced as documentation of activities that could alternatively have qualified under the “public use” or “on sale” gates. Depending on how one conceives of prior art in this subcategory, activity prior art may be even more significant than the top-level classifications would suggest.

D. U.S. Patents as Prior Art

The next category of prior art is U.S. patents—defined to include both granted patents and published applications. Because of the highly structured and centralized nature of these documents, we have the richest data on them of all the prior art categories. For example, we know precisely what was filed, when, by whom, and when that information actually became visible to the public. There are also a few special legal rules about how U.S. patents are treated as prior art, so a bit of background will be helpful here.

It might seem that, as a category, U.S. patents and patent applications would be the easiest form of prior art for a prospective inventor to discover. Granted patents and published applications are stored in a single, centralized repository.¹¹⁰ They are written in English. They are text searchable in a number of free, publicly accessible databases, including the PTO’s own website. And each patent and application has been assigned a field classification, allowing a searcher to quickly narrow her inquiry to the documents most likely to be relevant.¹¹¹ All of this would suggest that invalidations based on U.S. patent prior art will reliably constitute a valuable and highly incentivizing form of error correction.¹¹²

But there is a catch. Under certain conditions, U.S. patents and patent applications can be actually impossible for the inventor to find at the time she makes her application. The reason has to do with special prior art timing rules that apply only to U.S. patents and patent applications. The timing rule that applies to all other categories of prior art is straightforward: a disclosure becomes legally effective as prior art on the day that information becomes

109 Moreover, some of these publications were apparently only available through purchase of a larger product, which may make acquiring them financially impractical for libraries.

110 The PTO began publishing certain patent applications in the year 2000. Press Release, U.S. Patent & Trademark Office, USPTO Will Begin Publishing Patent Applications (Nov. 27, 2000), <https://www.uspto.gov/about-us/news-updates/uspto-will-begin-publishing-patent-applications>.

111 See *USPTO Patent Full-Text and Image Database*, U.S. PAT. & TRADEMARK OFF., <http://patft.uspto.gov/netahtml/PTO/search-bool.html> (last updated Oct. 22, 2019).

112 If one reason for revoking patents is to encourage reasonably diligent art searches before inventing or filing a patent, that reasonably diligent search surely includes a trip to the PTO’s own patent database. See MERGES & DUFFY, *supra* note 46, at 398–402; Yelderman, *Value of Accuracy*, *supra* note 12, at 1267–68, 1274–75.

available to the public.¹¹³ For example, a journal article qualifies as prior art on the day it is *published*;¹¹⁴ a sale of a product qualifies on the day that sale is made.¹¹⁵ But a different timing rule applies to U.S. patents and patent applications. Their disclosure qualifies as prior art on the day the underlying application was *filed*.¹¹⁶

What makes this tricky is that applications are legally protected as secret when they first arrive at the PTO.¹¹⁷ They can persist in this secret form until one of two things happens: (1) they are published (which typically occurs eighteen months after filing, though an applicant can opt out of this procedure); or (2) they result in a granted patent (typically many years after filing).¹¹⁸ Until one of those triggering events occurs, pending applications are not prior art. But the moment one of those things *does* occur, the application springs back in time, and becomes retroactively effective as prior art.¹¹⁹ No other category of prior art is treated this way.¹²⁰

Because of this springing rule, U.S. patents and patent applications can be either the most obscure form of prior art *or* the most accessible. The difference comes down to timing. If the prior art patent was published or granted before the focal patent was filed, it is certainly the kind of thing a reasonable art search should have uncovered. But if the prior art patent was not granted or published until later, the prospective inventor would have had no way of discovering it, no matter how much she may have invested in searching.¹²¹

113 See 35 U.S.C. § 102(a) (2006). Patents also formally qualify for this timing treatment, though the preferential rules discussed momentarily will render this path superfluous in many situations.

114 See *Constant v. Advanced Micro-Devices, Inc.*, 848 F.2d 1560, 1568 (Fed. Cir. 1988) (noting that printed publication is effective as prior art on the date it becomes publicly accessible).

115 There are, naturally, a few complications. For example, an offer for sale can qualify as prior art as soon as the invention is “ready for patenting”—even if the offer itself does not disclose any specific information about the invention. See *Pfaff v. Wells Elecs., Inc.*, 525 U.S. 55, 66–68 (1998).

116 See 35 U.S.C. § 102(e) (2006). This assumes, however, that they eventually publish or are granted. If not, these applications remain secret and never become prior art. See *id.* § 122.

117 See *id.*

118 See *id.*

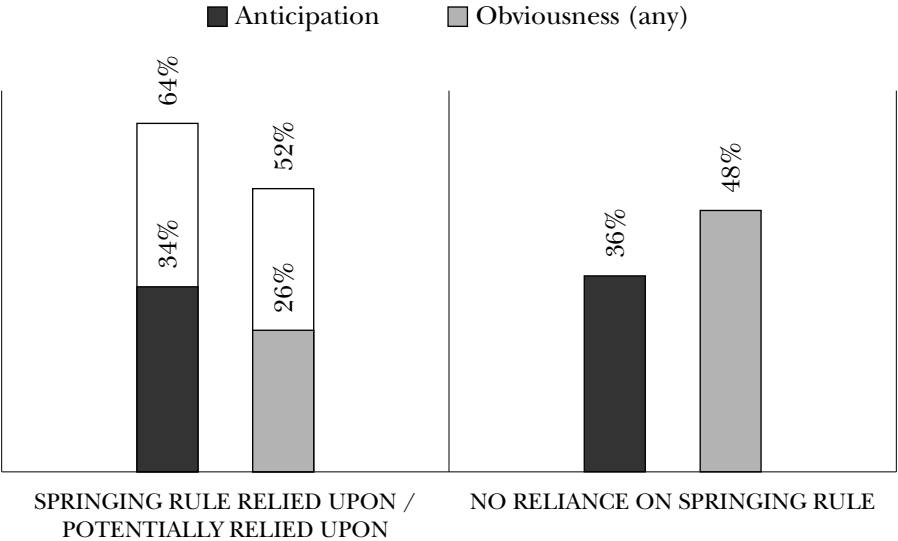
119 Sean B. Seymore, *When Patents Claim Preexisting Knowledge*, 50 U.C. DAVIS L. REV. 1965, 1969–71 (2017).

120 For an argument that printed publications ought to receive the same treatment, see *id.* at 1979–81.

121 This springing mechanism can even stymie patent examiners—though they have access to pending applications, they are not permitted to cite them until they become public. It is thus possible for a patent to be valid the day it is granted, but later become invalid as a result of subsequent events in the life of a different pending application.

Though this special treatment of U.S. patent prior art is nearly a century old,¹²² it appears that its effects have never been quantified. To determine the frequency with which courts rely on these rules, we supplemented our district court dataset with various PTO datasets providing application filing, publication, and grant dates for both the focal and cited patents.¹²³ Comparing these dates allowed us to place each invalidity event into one of three categories: (a) the springing mechanism was unambiguously necessary for the cited patent to qualify as prior art; (b) the springing mechanism was unambiguously *unnecessary* for the cited patent to qualify as prior art; or (c) the springing mechanism *might* have played a role in qualifying the cited patent as prior art.¹²⁴

FIGURE 5: U.S. PATENT PRIOR ART



122 The springing prior art rule was created judicially, though it has since been codified. See *Alexander Milburn Co. v. Davis-Bournonville Co.*, 270 U.S. 390, 400–02 (1926); 35 U.S.C. § 102(e) (2006).

123 We use the term “focal patent” to refer to the patent that is the subject of the validity inquiry. In contrast, the “cited patent” is the one that threatens to invalidate the focal patent.

124 The reason we could not always conclusively determine whether there was reliance on the springing prior art rule is that, in some scenarios, qualification as prior art would have depended on the focal patent’s date of invention, which is distinct from its filing date. For example, if the cited patent was granted or published less than a year before the focal patent was filed, its status as prior art (in a world without springing rules) would turn on when the invention of the focal patent was actually invented. Date of invention is a complex question for litigation, and one that the springing rule itself may have avoided the need to litigate. In these ambiguous cases, the springing mechanism made it easier to qualify the prior art, but we cannot say whether or not the same art would have qualified absent a springing mechanism.

As Figure 5 illustrates, the springing mechanism of U.S. patents appear central to their use as prior art by district courts. In 34% of the claim-level anticipation events in which the focal patent was anticipated by a U.S. patent, the springing timing rule was unambiguously necessary for the cited patent to qualify as prior art.¹²⁵ Moreover, in an additional 30% of these anticipation events, the springing prior art rules *might* have played a role in qualifying the cited patent as prior art. In only 36% of anticipation events based on U.S. patents was the springing prior rule unambiguously unnecessary.¹²⁶ The upshot, though, is that anticipation based on U.S. patents is overall quite rare—U.S. patents are cited in only about 19% of all anticipation events to begin with. From the perspective of invalidity overall, the springing rule was relied upon for somewhere between 7% and 16% of anticipation events.

For obviousness, the percentage of patents relying on springing rules to qualify as prior art was also quite high. In 26% of claim-level obviousness decisions that cited any U.S. patents, the springing rule was necessary to qualifying one or more of them. Moreover, in another 26% of claim-level obviousness decisions that cited any U.S. patents, the springing rule was *potentially* necessary to qualifying one or more of them. In only 48% of obviousness events citing U.S. patents was there unambiguously no reliance on the springing prior art rules. But in contrast with anticipation, obviousness draws on U.S. patents as prior art with great frequency.¹²⁷ From the perspective of invalidity overall, somewhere between 18% and 35% of all obviousness invalidations relied on patents that were secret at the time of filing.

Unless the content of these applications was also disclosed somewhere else, it is hard to see how these could be inventor-incentivizing error correction. At the time the applicant filed her patent, there was no lawful way for

125 To qualify for the “certain reliance” category, the prior art patent could not have been published or issued until a date *after* the focal patent’s priority date. For purpose of determining the priority dates of focal patents, we considered only the most reliable forms of priority claims—continuations, divisionals, reissues, and national entry from a Patent Cooperation Treaty application. We excluded priority claims that are more vulnerable to attack in litigation, such as foreign priority claims, provisionals, and continuations-in-part. This will tend to understate the number of cases in which the springing rules were necessary to qualify the patent as prior art.

126 To qualify for the “no reliance” category, the prior art needed to be published or issued more than one year prior to the focal patent’s earliest domestic priority claim. In these cases, the challenger could rely on § 102(b), making the springing mechanism irrelevant. See 35 U.S.C. § 102(b) (2006).

We should emphasize that we have been extremely conservative in drawing the line between cases in which the springing rules certainly or possibly played a role in qualifying the patent as prior art. For example, a large number of anticipating patents would have moved into the “certain” column if we had assumed that the focal patent was entitled to the benefit of its provisional filing date. In these cases, the springing prior art rules made the provisional filing irrelevant. However, we classified these as cases of potential reliance because, in a hypothetical world without the springing prior art rules, the focal patent’s priority claim to that provisional *might* have failed.

127 Recall that 63% of obviousness events cited at least one U.S. patent. See *supra* Figure 3.

her to access the prior art that later invalidated her claims. Invalidation on these facts might serve some purposes, but creating future incentives for inventors to break into the PTO to read secret applications is not one of them.

E. Activity

As noted above, more than half of anticipation events rely on art in the “activity” category—prior uses, sales, and earlier invention by someone else. And nearly a third (28%) of obviousness events drew at least partially on prior activities.

The obscurity of art in the activity category can vary widely. For example, prior invention by another¹²⁸ is almost inevitably obscure. (If the prior inventor had sold or allowed the public to use the invention, those activities would qualify directly, avoiding the need to jump through the doctrinal hurdles of prior invention.)¹²⁹ Uses and sales, by contrast, can be extremely prominent—such as a keynote address streamed around the world, or a product sold to millions of customers.¹³⁰ But they can also be more discrete than that. Only a single use or sale is necessary to create activity prior art.¹³¹ And that single use or sale could be something as undiscoverable as a two-party contract,¹³² or an undergarment worn under clothing around town.¹³³

The good news is that the obscure outer reaches of the doctrine appear to be relied upon only rarely. Prior invention by another, for example, constitutes a distinct minority of activity prior art. Among anticipation events citing activity, prior invention was the basis for only about 8% of claim invalidations. Prior invention played a role in obviousness in a trivial number of cases—about 1.1% of obviousness events citing any activity. Together, they represented a very small share of invalidity overall—roughly 2.4% of all claim-level invalidation events. And that number will only be going down over time, as the category was completely eliminated through recent statutory amendments.¹³⁴

128 See 35 U.S.C. § 102(g)(2) (2006).

129 See *Thomson, S.A. v. Quixote Corp.*, 166 F.3d 1172, 1175–76, 1175 n.3 (Fed. Cir. 1999) (summarizing requirements for § 102(g)(2)).

130 Famously, one of Apple’s German patents was invalidated based on Steve Jobs’s original iPhone keynote address. Mikey Campbell, *Steve Jobs’ Original iPhone Keynote Video Used to Invalidate Apple Patent in Germany*, APPLEINSIDER (Sept. 26, 2013), <https://appleinsider.com/articles/13/09/27/steve-jobs-original-iphone-keynote-video-used-to-invalidate-apple-patent-in-germany>.

131 See, e.g., *id.*

132 See, e.g., *Pfaff v. Wells Elecs., Inc.*, 525 U.S. 55, 62–63 (1998).

133 See *Egbert v. Lippmann*, 104 U.S. 333, 337–38 (1881).

134 See Leahy-Smith America Invents Act, Pub. L. No. 112-29, § 3(b), 125 Stat. 284, 285–87 (2011) (codified at 35 U.S.C. § 102 (2012)). These new rules take effect based on a patent’s effective filing date, see *id.* § 3(b)(1), so courts will continue to apply the pre-AIA prior art rules in at least some cases for many years. During our study period the pre-AIA prior art rules were overwhelmingly the operative law; in fact, we observed only one case of a court applying the new, post-AIA prior art rules. The infrequency with which courts

It is difficult to determine whether a particular invalidating use or sale was widespread, as the prominence of a use or sale is usually doctrinally irrelevant. To get a bit of purchase on this question, we coded whether activity prior art was based on *potentially* secret uses or sales, such as when proof of a prior sale relied on a particular contract or proposal,¹³⁵ or the public use was performed by a limited and specifically identified group of people.¹³⁶ Construing these categories as broadly as possible,¹³⁷ it nonetheless appeared that nonpublic uses and sales made up a small fraction of activity prior art. Potentially secret uses or sales were the basis for only about 14% of anticipation invalidations citing activity prior art.¹³⁸ For obviousness, these cases were even rarer: only about 2% of obviousness invalidations relying on activ-

relied on prior invention under pre-AIA law suggests that the elimination of this category will not significantly affect our results.

135 For a canonical example in this category, see *Pfaff*, 525 U.S. at 67–68 (noting that a purchase agreement with a single customer triggered the “on sale” bar).

136 For canonical examples in this category, see *Egbert*, 104 U.S. at 337 (noting that friend’s unrestricted use of corset constituted public use); *JumpSport, Inc. v. Jumpking, Inc.*, 191 F. App’x 926, 935 (Fed. Cir. 2006) (noting that neighbors’ use of trampoline in inventor’s backyard constituted public use); and *Lough v. Brunswick Corp.*, 86 F.3d 1113, 1121–22 (Fed. Cir. 1996) (explaining that five demonstration prototypes installed on the boats of friends and associates constituted public use). This category also included cases in which the inventor used the patented method in house for ultimately commercial purposes. See *D.L. Auld Co. v. Chroma Graphics Corp.*, 714 F.2d 1144, 1147–48 (Fed. Cir. 1983) (noting that inventor used patented method to manufacture products, which it then offered for sale); see also *Metallizing Eng’g Co. v. Kenyon Bearing & Auto Parts Co.*, 153 F.2d 516, 520 (2d Cir. 1946) (recognizing this as prior art).

While “performed by a limited and specifically identified group of people” may sound vague in principle, it was straightforward in application. Public uses at trade shows were excluded from this subcategory because they presumably involved use by an open set of attendees. No other public use cases presented a close question of classification.

137 These subcategories are likely overbroad, and therefore may tend to overstate the significance of secret prior art. For example, a private sale made under a bilateral contract may or may not have been secret, particularly since we identified confidentiality obligations for a very small number of such sales. We employed these categories (despite their likely overbreadth) in hopes of establishing an upper bound on the number of cases relying on nonpublic uses and sales. In the other direction, it is possible that we may have omitted some cases of secret activity in which the activity’s qualification as prior art simply went uncontested. For example, if the parties stipulated to the activity qualifying as prior art, the record may have been silent on the nature of the use or sale, and we may have coded it as a case of implicitly public activity. However, because the path to qualifying secret activities as prior art is fraught with multifactor balancing tests and exceptions, see *Dey, L.P. v. Sunovion Pharm., Inc.*, 715 F.3d 1351, 1355 (Fed. Cir. 2013), we think it is unlikely that there would be many cases in which the patent holder would avoid raising that issue when it was otherwise contestable. Nonetheless, to the extent patent holders may have conceded that certain nonpublic activities qualified as prior art, our data may understate the significance of secret prior art.

138 For an additional 1.4% of anticipation events citing activity, the potentially secret nature of that activity was coded as “unknown.” These were cases in which the court relied on activity prior art, but sealed records or other obstacles prevented us from discerning whether the art bore indicia of potentially secret activity.

ity prior art cited any potentially secret uses or sales.¹³⁹ As a share of invalidity overall, secret uses and sales were cited in fewer than 4.25% of claim invalidations.¹⁴⁰

But even aside from these rare cases of prior invention and potentially secret uses and sales, the incentivizing value of invalidation based on prior activities remains ambiguous. For one, public uses and sales that are undeniably public can still be small scale—such as the sale to a handful of select customers. Moreover, even when a use or sale was widespread, these activities may not leave the kind of publicly searchable records that a third party could be expected to find years after that activity has ceased. If an inventor did not have actual knowledge of a prior use or sale, it is difficult to say whether she ought to have known about that use or sale.

Nonetheless, cutting across all of these complications, there is one class of activities that the inventor certainly should have known about: uses and sales she conducted herself. Revoking patents in light of the inventor's own prior activities is a reliably incentivizing form of error correction. As the Supreme Court has explained, a principal reason for having this prior art category in the first place is to prevent inventors from extending the patent term.¹⁴¹ If an inventor could reap commercial benefit from her invention and file a patent many years later, she could enjoy effectively exclusivity much greater than the statute prescribes. Revoking a patent in that situation discourages such subterfuge, vindicating a core justification for the prior use/sale category.¹⁴²

For similar but distinct reasons, invalidation based on the *defendant's* prior activities is a reliably valuable form of error correction. A defendant asserting his own prior uses and sales as prior art is not seeking to escape liability on a technicality of patent law. Rather, he is asserting his right to continue the activities he has been performing since before the inventor came along. Though not necessarily incentivizing for future inventors, revoking patents that would cover the defendant's preinvention activities serves an important function in ensuring that the patent system does not take things out of the public domain.¹⁴³

To attempt to classify invalidity events on these lines, we coded instances in which the court mentioned that the invalidating activity was performed by one of the parties. The results of this coding are shown in Figure 6.

139 For an additional 4.4% of obviousness events citing activity, the potentially secret nature of that activity was coded as “unknown.”

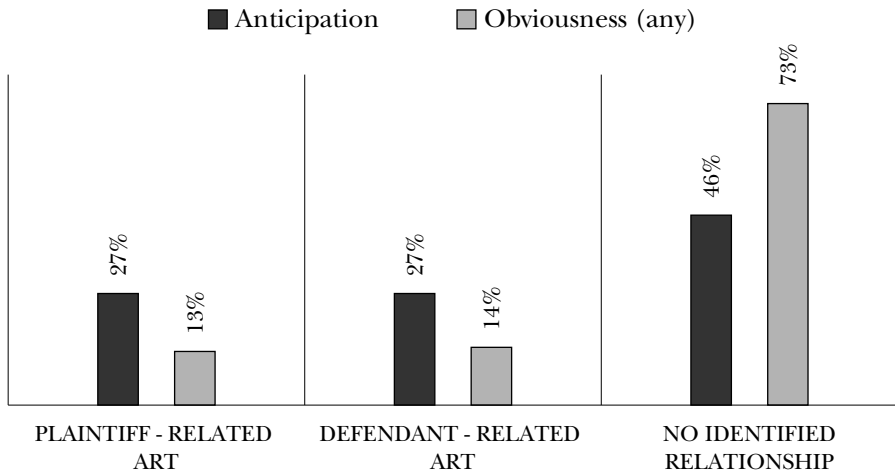
140 If one includes cases in which the potentially secret nature of that activity was coded as “unknown,” this upper limit rises to 5.3%. Note that there was recently a live controversy as to whether the “secret uses and sales” category of prior art might have been abrogated by the AIA. We now know that it was not. *See Helsinn Healthcare S.A. v. Teva Pharm. USA, Inc.*, 139 S. Ct. 628, 630 (2019) (holding that AIA did not change the meaning of “on sale”).

141 *See Pfaff v. Wells Elecs., Inc.*, 525 U.S. 55, 63–64 (1998).

142 *See Helsinn Healthcare, S.A.*, 139 S. Ct. at 632–33.

143 *See Kewanee Oil Co. v. Bicron Corp.*, 416 U.S. 470, 484 (1974).

FIGURE 6: BASIS FOR INVALIDITY—ACTIVITY



As Figure 6 shows, the majority of anticipating activities could be traced back to one of the parties in suit. Among anticipation events citing activity, 27% involved plaintiff-related activities, and another 27% involved defendant-related activities. Less than half (46%) of anticipating activities had no identifiable relationship to either party.

The same does not hold for obviousness, however. Among obviousness events citing any activity prior art, 13% cited any plaintiff-related activity, and another 14% cited any defendant-related activity. The vast majority of activity-based obviousness events (73%) involved activity that could not be traced to either party.

We must acknowledge some potential for underreporting of party relationships. There is often no legal significance to the fact that a sale or use was made by the plaintiff or the defendant, so in many cases the court may simply not have mentioned a party relationship, even if one was present.¹⁴⁴ Therefore, the “no identified relationship” category likely includes *some* invalidation events involving party-related art that our coding failed to identify.

Despite these limitations, this is overall encouraging news for the value of invalidation based on anticipation. As mentioned above, prior invention and potentially secret uses and sales were rarely the basis for anticipation. But it was even *more* unusual for a court to rely on those activities when they bore no relationship to either party. Fewer than 4% of all anticipation invalidations cited the prior invention or potentially secret uses or sales of a non-party. By contrast, the prior activities of either the plaintiff or the defendant comprised about 28% of all anticipation events.

¹⁴⁴ This might explain the apparent disparity in third-party activity art relied upon for obviousness compared to anticipation—with multiple references at play, it may have been less likely for the court to mention a party relationship in passing. Alternatively, obviousness invalidations may simply be more likely to rely on third-party activities.

The obviousness data fails to present a similarly upbeat picture. While obviousness based on prior invention or potentially secret uses or sales is quite rare, we were unable to discern a party relationship for the vast majority of activities cited as prior art. This does not mean these invalidations were *not* incentivizing (or that they lack value under some other theory)—it simply means we could not find the same indicia of error-correction value in cases of obviousness that we were able to find in cases of anticipation.

F. Foreign Patents

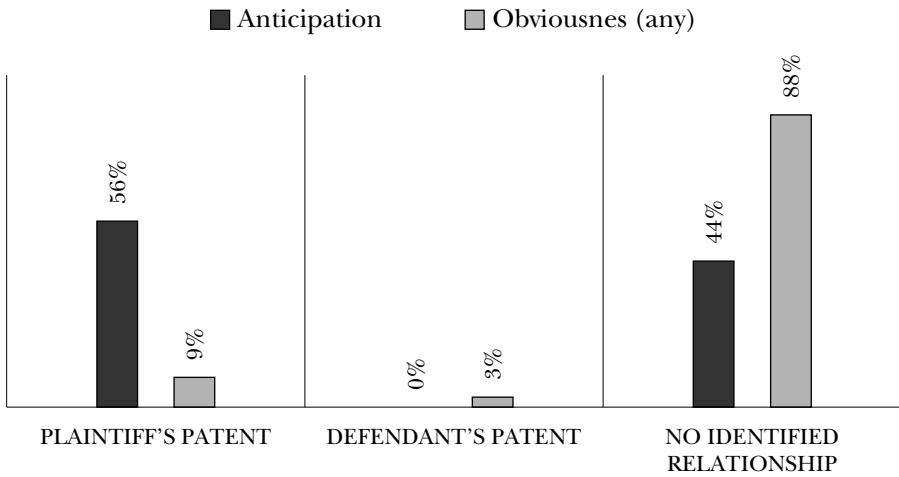
By any measure, foreign patents were the category of prior art least commonly relied upon in district court. Still, about 10% of anticipation invalidations relied on foreign patents, and 20% of obviousness invalidations were built in partial reliance on them. This reliance was almost always partial—as a category, foreign patents were sufficient by themselves to establish obviousness in only 2% of obviousness events. Thus, in the vast majority of obviousness events involving a foreign patent, the court combined that patent with a reference in another category.

It is difficult to generalize about the obscurity of foreign patents. On the one hand, they exist in centralized repositories. On the other hand, the ease of searching foreign patents can vary greatly depending on the country. In the majority of foreign patent offices, the proceedings are conducted in a language other than English. And, of course, there are a lot of patent offices—well over a hundred—spread all around the world.¹⁴⁵

That said, for many cases in this category, searching foreign patent offices wouldn't actually be necessary. In over half of anticipation events involving a foreign patent, it was the inventor's *own* foreign patent that was the problem:

145 At last count, there are 164 signatories to TRIPS and 153 signatories to the Patent Cooperation Treaty. See *Other IP Treaties: Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS Agreement)*, WORLD INTELL. PROP. ORG., http://www.wipo.int/wipo-lex/en/other_treaties/parties.jsp?treaty_id=231&group_id=22 (last visited Oct. 9, 2019); *The PCT Now Has 153 Contracting States*, WORLD INTELL. PROP. ORG., http://www.wipo.int/pct/en/pct_contracting_states.html (last visited Oct. 9, 2019).

FIGURE 7: BASIS FOR INVALIDITY—FOREIGN PATENT



As Figure 7 illustrates, among anticipation events citing a foreign patent, 56% relied on the inventor's own foreign patent. We did not identify a single instance of the defendant's foreign patent leading to anticipation. The remaining 44% of anticipation events cited a foreign patent with no identified party relationship.

Moreover, it appears that even these remaining 44% of foreign patents could have been found with a modest amount of searching. Excluding cases in which the inventor's own foreign patent was the fatal prior art, 92% of the foreign patents cited for anticipation could have been found by searching just three foreign patent offices: the Japan Patent Office, the European Patent Office, and the World Intellectual Property Organization. It was extremely rare for a U.S. patent to be anticipated by a foreign patent that bore no relationship to the plaintiff and that could not be found in those three offices. Such cases constituted less than 1% of all anticipation events.

The inventor's-own-patent explanation does much less work when it comes to obviousness. Among obviousness events drawing on any foreign patents, only 9% involved a foreign patent with an identified relationship to the U.S. inventor. We did identify 3% of obviousness events involving a foreign patent with a relationship to the defendant. Still, 88% of obviousness events citing a foreign patent, we could not identify any relationship between that foreign patent and the parties in suit.¹⁴⁶

In addition, a wider search would sometimes be required to find the nonparty foreign patents cited for obviousness than it would in cases of anticipation. Searching at the Japan Patent Office, the European Patent Office,

¹⁴⁶ As with activity, however, there is potential for undercounting. The fact of a party relationship would not always be legally relevant and so may have gone unmentioned by the court. We therefore expect that the "no identified party relationship" category likely includes some cases in which there *was* such a relationship that simply went unidentified.

and the World Intellectual Property Organization would yield all the foreign patents cited in 70% of these obviousness events. A (virtual) trip to another easily searchable office, the United Kingdom's, would add another 13%. But that still leaves 17% of obviousness invalidations citing foreign patent prior art that was not that plaintiff's own work and that would require a much broader search to discover.¹⁴⁷ It is harder to make the case that these invalidations increase future incentives to search the prior art. The good news is that because foreign patents are an uncommon source of prior art in general, these make up a small percentage of obviousness invalidation overall—just above 3%.

* * *

In sum, the incentivizing value of district court anticipation decisions appears to be quite high. Beginning with the most common category of prior art, the majority of anticipating activities were attributable to either the plaintiff or defendant in the suit. It was quite rare for a patent to be invalidated because the invention was previously invented by another, or because it had been secretly used or sold by a nonparty. As for anticipating publications, the majority that were cited were regularly published books and journals. Presentations, handouts, and other nontraditional publications were cited only occasionally. In the rare cases in which foreign patents were cited, they were typically the inventor's own prior patents, and even those that were not could usually be found in just three foreign patent offices. The most commonly cited form of obscure, anticipating prior art were secret U.S. patent applications, which made up somewhere between 7% and 13% of anticipation events overall.

By contrast, the picture of obviousness is in many ways ambiguous, and when it is not ambiguous, it is discouraging. Whether the cited art was an activity or foreign patent, it rarely had an identifiable party relationship. This is possibly a result of underreporting—courts simply may not have taken the time to mention party relationships when there were multiple references at issue. But it could also reflect greater obscurity in the art used to show obviousness. Taken at face value, the data suggests it was unusual for the patent owner or defendant's own prior work to be cited to establish obviousness.

Putting aside party relationship, obviousness invalidations often relied on obscure prior art. Nontraditional publications were cited in approximately 9% to 16% of obviousness events.¹⁴⁸ Foreign patents were cited in 20% of obviousness events,¹⁴⁹ and those patents came from a longer tail of

147 Beyond these four patent offices, we observed small numbers of obviousness invalidations citing patents from Australia, Brazil, Canada, China, France, Germany, and Portugal. Each of these constituted fewer than 4% of all obviousness invalidations citing any foreign patent. In addition, for about 3% of the obviousness events citing a foreign patent, the country of that foreign patent was coded as "unknown."

148 See *supra* Figure 4. This range is approximate because of publications in the "unclassified" category. See *supra* p. 864.

149 See *supra* Figure 3.

foreign patent offices.¹⁵⁰ And secret U.S. patent applications were cited in somewhere between 18% and 35% of obviousness events overall. In sum, it appears that somewhere between a third and a half of obviousness invalidations drew on prior art not easily accessible to a person of skill in the art at the time of the invention. These invalidations could still yield public benefits, but evidence from the district court fails to show that they reliably provided an inventor-incentivizing form of error correction.

IV. POTENTIAL BENEFITS OF REPLACING LITIGATION WITH EXAMINATION

Apart from assessing the public benefits of patent litigation, one might also wonder whether a different procedural tool could provide similar benefits at lower cost. The expense of invalidating patents in district court is sobering. For example, a rough calculation would suggest that invalidating these 3320 claims on prior art grounds likely cost the parties something around \$3 billion¹⁵¹—or roughly \$1 million *per invalidated claim*.¹⁵² (And that number does not even include the court's time or discovery costs imposed on third parties.) If a different procedural mechanism could produce similar public benefits at lower cost, it may be preferable to district court patent litigation.

An obvious competing tool for this job is the initial round of examination at the PTO. Every single one of the claims invalidated in court was previously scrutinized by the expert agency and ruled to be patentable. Millions of dollars and several years later,¹⁵³ a court reached the opposite conclusion. Even if the PTO is imperfect, it certainly seems plausible that the agency

150 See *supra* note 146 and accompanying text.

151 This back-of-the-envelope figure is derived as follows: The 3320 claims invalidated on prior art grounds involved 233 patents litigated to summary judgment and 258 patents litigated through trial. Because roughly half of patent challenges succeed, we must double those numbers to calculate the number of judgments necessary to produce those invalidations. See Allison et al., *Realities of Modern Patent Litigation*, *supra* note 16, at 1787; Allison & Lemley, *supra* note 63, at 205. Finally, litigation surveys indicate that fighting a patent to summary judgment costs *each party* about \$1 million, and that fighting a patent to trial costs each party about \$2 million. AM. INTELLECTUAL PROP. LAW ASS'N, 2017 REPORT OF THE ECONOMIC SURVEY 46 (2017). Thus, the estimated costs in party attorneys' fees for these cases come to $(2 \times 233 \times 2 \times \$1 \text{ million}) + (2 \times 258 \times 2 \times \$2 \text{ million}) = \$2.996 \text{ billion}$. This estimate is extremely conservative. For comparison, Mark Lemley has suggested that we spend about \$2.1 billion *per year* litigating patents. Lemley, *supra* note 21, at 1502. Frakes and Wasserman imply the number is about \$1.3 billion per year. See Michael D. Frakes & Melissa F. Wasserman, *Irrational Ignorance at the Patent Office*, 72 VAND. L. REV. 975, 1001–02 (2019) (5561 expected case-application pairs per year multiplied by \$234k per case-application pair).

152 To be clear, some of these cases also invalidated additional claims on non-prior art grounds, which are not counted in the total above. We cannot say exactly how many additional claims were invalidated on non-prior art grounds, as we coded these invalidations only at a patent level. However, about 15% of the patents experiencing prior-art-based invalidity also experienced non-prior-art invalidity during the study period.

153 The median claim in our dataset had been in force for about six years at the time it was invalidated—and 25% of claims had been in force for nearly eleven years or more.

could have avoided issuing these 3320 claims for something less than \$3 billion.

The challenge with catching unpatentable claims at the examination stage is that the volume of patents examined is orders of magnitude larger than the volume of patents litigated to judgment. For example, in fiscal year 2015, the PTO received 589,410 utility patent applications and granted 298,407 utility patents.¹⁵⁴ Since we observed an average of 196 distinct patents invalidated in court a year, that means that for every single patent invalidated in court, there were about 3000 applications filed and 1500 patents granted. So while the PTO might be able to catch invalid patents more cheaply than courts, those cost advantages are potentially offset by the sheer volume of applications that must be put through the examination process.

For fifteen years, the prevailing view—best articulated in Mark Lemley’s highly influential article, *Rational Ignorance at the Patent Office*¹⁵⁵—has been that initiatives to expend more resources at the examination stage cannot survive cost-benefit analysis.¹⁵⁶ Relying on some rough figures and a number of assumptions, Lemley showed that it would be extremely difficult for increased examination scrutiny to pay for itself by reducing the need for patent litigation.¹⁵⁷ Because so many more patents are examined than litigated, the argument goes, litigation cost savings are almost structurally incapable of justifying higher examination costs. Instead, we are better off with a “just-in-time” model of accuracy, in which low-intensity examination is followed by high-intensity litigation in the small number of cases that require it.¹⁵⁸

A recent empirical project, however, has challenged Lemley’s assumptions and called for a reconsideration of the viability of increasing examination scrutiny. In *Irrational Ignorance at the Patent Office*, Michael Frakes and Melissa Wasserman draw on micro-level application data to predict that the benefits of giving patent examiners more time *would* offset its substantial costs.¹⁵⁹ Though there are a number of components to their analysis, their most important divergence from Lemley comes down to the volume of patent litigation that could be precluded through greater investment at the examination stage. For purposes of rough calculation, Lemley assumed that doubling the amount of time available to examiners for each patent application would reduce the number of issued patents (and therefore patent litigation).

154 U.S. Patent Statistics Chart: Calendar Years 1963–2018, U.S. PAT. & TRADEMARK OFF., https://www.uspto.gov/web/offices/ac/ido/oeip/taf/us_stat.htm (last updated Nov. 26, 2019).

155 Lemley, *supra* note 21. It would be difficult to overstate the influence of *Rational Ignorance*—as of this writing, it had been cited more than 640 times, according to Westlaw. A recent analysis listed *Rational Ignorance* as the ninth-most-cited private-law article in the last twenty-five years. Ted Sichelman, *Most Cited Private Law Articles Published in the Last 25 Years*, NEW PRIV. L. (Apr. 22, 2015), <https://blogs.harvard.edu/nplblog/2015/04/22/most-cited-private-law-articles-published-in-the-last-25-years/>.

156 See Lemley, *supra* note 21, at 1497.

157 See *id.* at 1507–11.

158 See *id.* at 1510–11.

159 Frakes & Wasserman, *supra* note 151, at 1020–24.

tion) by 10%.¹⁶⁰ Relying on their newly available data, Frakes and Wasserman predict that doubling examination time would actually reduce litigation by 44%¹⁶¹—more than four times what Lemley originally assumed. This single figure drives \$491 million of their predicted annual costs savings and is essential to their conclusion that we should be investing more at the examination stage to improve patent quality.¹⁶²

In short, one of the most important and frequently discussed policy questions in the administration of patent law—whether the PTO should be given more resources—comes down to an empirical prediction about how much patent litigation could be precluded as a result of more examination.¹⁶³ And, on this question, district court invalidity data can provide some additional insight. Frakes and Wasserman's 44% prediction is based on a careful and detailed study of examination. But how plausible is this projection when viewed from the litigation side of the mountain? Do district courts invalidate claims based on prior art the PTO already knew about? If not, was the invalidating prior art something an examiner realistically could have found?

This Part draws on our district court dataset to explore the likelihood that increased investment in examination could avoid the need for patent litigation.

A. *Prior Art and Examination Time*

Examining a patent application for anticipation and obviousness is a two-step process. First, the examiner must search for potentially relevant prior art. Second, the examiner must understand the art she finds and apply it to make determinations about anticipation and obviousness. The second

160 See Lemley, *supra* note 21, at 1508–09.

161 Frakes & Wasserman, *supra* note 151, at 1022–24.

162 See Frakes & Wasserman, *supra* note 151, at 1003. Note that their findings diverge in other significant ways as well. For example, Lemley assumed that increasing examination scrutiny would cause a fifty percent increase in the cost of obtaining a patent; Frakes and Wasserman find that this increased scrutiny may actually reduce patent prosecution costs overall. Compare Lemley, *supra* note 21, at 1508, with Frakes & Wasserman, *supra* note 151, at 1024.

163 This is not to deny the possibility of other benefits. Indeed, Frakes, Wasserman, Lemley, and I *all* acknowledge that litigation costs avoided are only one benefit that might justify increased expenditures on examination. See Frakes & Wasserman, *supra* note 151, at 1013–16; Lemley, *supra* note 21, at 1515–20; Stephen Yelderman, *Coordination-Focused Patent Policy*, 96 B.U. L. REV. 1565, 1599–1600 (2016) (suggesting that settling questions about patent rights at an earlier stage would increase parties' ability to order their affairs in the shadow of patents in the future); Yelderman, *Increasing Competition*, *supra* note 11, at 1959–61, 1980–85 (observing that litigation will not always fully mitigate the deadweight losses imposed by invalid patents). Litigation expenses avoided seem to occupy a central position in the cost-benefit analysis only because they are amenable to quantification: the costs of patent litigation are direct and publicly reported, making it straightforward to make back-of-the-envelope predictions about savings. By contrast, the other potential benefits of increasing examination are often indirect and difficult to observe.

step logically depends on the first in the sense that an examiner cannot understand and apply prior art she does not have.

In terms of the additional examination time necessary to avoid issuing an invalid patent, we can draw a distinction between failures at step one and step two. The lowest-hanging fruit would seem to be cases in which the examiner knew about the relevant prior art and failed to appreciate its significance. In cases like these, it is imminently plausible that a bit more time would allow an examiner to avoid granting a patent, since all she would need to do is better understand the prior art already in front of her.

Cases in which the examiner did not know about the fatal prior art are trickier. To avoid issuing a patent, the examiner would need to perform both steps a bit differently: she would first need to find that additional piece of prior art, and then she would need to correctly appreciate and apply it. Additional examination time could still reduce the number of court-invalidated patents falling into this category, but logically the effectiveness of that additional time will be lower.

We can further subdivide cases in which the prior art was not known to the examiner, depending on whether the fatal prior art was the kind that could be found by additional examination-style search. If the missing prior art was a patent or a regularly published book or journal, it is plausible that additional examination time would have made a difference. But if the missing prior art was an activity or a nontraditional publication, it is hard to see how additional time would have led to a different outcome.

In sum, to assess the likelihood that an increase in examination time would have avoided the need for litigation, we can classify our invalidation events in this way:

TABLE 2

Category 1	Category 2	Category 3
All invalidating references known during examination	One or more invalidating references unknown during examination, but all unknown references were patents or regularly published books or journals	One or more invalidating references unknown during examination and falling in activity or nontraditional publication category
<i>Higher return on increased examination time</i>	<i>Lower return on increased examination time</i>	<i>No return on increased examination time</i>

Category 1 invalidations are cases in which every reference necessary to sustain the district court invalidation was part of the examination record. We assume that these would be the highest-yield cases, in which a bit of additional examination time could go a long way. By contrast, Category 2 invalidations are those in which at least one reference relied upon in court was not

known during examination, subject to the constraint that any unknown reference was a patent (U.S. or foreign) or regularly published book or journal. Logically, increased examination scrutiny would avoid fewer of these invalidations than Category 1, but it is nonetheless plausible that a modest increase in examination time could avoid the need for some of the litigation that leads to these invalidations.

Category 3 invalidations are cases in which at least one reference relied upon in court was not known during examination *and* that missing prior art reference was an activity or nontraditional publication. Because the unknown art in these cases was practically unsearchable, we assume that no plausible reform to examination practice would have precluded the issuance of these patents. For example, whether we double or triple examination time, nothing short of imaginary reform to the PTO would suddenly permit examiners to travel to the trade shows, conferences, or far-flung locales where activities and nontraditional publications might be found.¹⁶⁴

Before turning to the data, we must acknowledge an important limitation of this classification scheme. Our observations are based on patents litigated to a decision of invalidity, which may have different characteristics than patents overall.¹⁶⁵ Moreover, litigants determine not only which patents to litigate but also *how* to litigate them. In particular, we expect that a challenger to an issued patent will have a strategic interest in avoiding Category 1 art when possible. This is because claims that have been issued by the patent office enjoy a statutory presumption of validity, meaning that a district court may invalidate them only on the basis of “clear and convincing evidence.”¹⁶⁶ But this presumption can be weakened by invoking prior art that was not considered by the PTO.¹⁶⁷ It is therefore in a challenger’s interest to search

164 This is not to say that the Category 3 cases are hopeless. Reducing the number of litigated cases in this category would simply require other tools besides more examination time—such as increasing incentives for the applicant and third parties to disclose relevant prior art. See generally Stephen Yelderman, *Improving Patent Quality with Applicant Incentives*, 28 HARV. J.L. & TECH. 77 (2014).

165 For this reason, the following data should not be used to make any inferences about patent quality overall, or even the effect that increased examination might have on the number of patents asserted in court annually. The question of interest here is how many *decisions of invalidity* could be precluded through increased examination. For further discussion, see *infra* notes 174–77 and accompanying text.

166 *Microsoft Corp. v. i4i Ltd. P’ship*, 564 U.S. 91, 97 (2011).

167 *Id.* at 110. Formally, the presumption of validity applies whether or not the evidence was known to the PTO during examination. See *id.* At the same time, however, the Court has recognized that new evidence often carries “more weight” than old evidence, and has held that the jury may be specifically instructed to consider that “it has heard evidence that the PTO had no opportunity to evaluate before granting the patent.” *Id.* at 110–11. In experimental settings, an instruction like this one seems to have the same effect as if no heightened presumption of validity applied at all. See David L. Schwartz & Christopher B. Seaman, *Standards of Proof in Civil Litigation: An Experiment from Patent Law*, 26 HARV. J.L. & TECH. 429, 432, 459–60 (2013). Moreover, prior studies have suggested that a challenge to patent validity is more likely to succeed if it is rooted in new art rather than art that was known at the time of examination. See Allison & Lemley, *supra* note 63, at

for and rely on prior art that was not before the PTO at the time of examination, even if a strong case could also be made on the basis of the art that *was* before the PTO.

As a result, we expect that challengers will sometimes seek to show a patent is anticipated or obvious on the basis of Category 2 or Category 3 art, even if a challenge based on Category 1 art would objectively have been just as strong. As a result, the data may tend to understate the potential effectiveness of additional examination, at least between Category 1 on the one hand and Categories 2 and 3 on the other hand.¹⁶⁸ We will begin by putting this potential bias aside, taking the data at face value to assess the plausibility of Lemley, Frakes, and Wasserman's predictions. In the end, we will explore whether this potential complication is likely to change our conclusions.

B. *Examining for Anticipation*

About half of the 3320 claims we observed invalidated in district courts were invalidated based on anticipation. Given the strategic considerations introduced above, one might predict that it would be quite rare to find invalidations in Category 1. And yet, our data show that this happens with surprising frequency—about 30% of all claim-level anticipation events relied on art listed right on the face of the patent.¹⁶⁹ This is encouraging news for the feasibility of precluding litigation by greater examination scrutiny.

Moreover, the percentage of claim-level anticipation events relying on Category 1 was much higher for some prior art categories than others:

231–34. (Note, however, that Allison and Lemley combined obviousness and anticipation for purposes of this analysis. *Id.* at 232 tbl.10.) For earlier studies of this question, see Federico, *supra* note 71, at 249; KOENIG, *supra* note 67, at 5–50.

168 As between Category 2 and Category 3, we expect that challengers would tend to rely on prior art in Category 2 when given the option. Nontraditional publications may trigger factual disputes over whether they satisfy the Federal Circuit's multipart test for qualifying as a "printed publication," and activity prior art can raise a host of questions about whether something was really on sale, available for patenting, being used only for experimentation, and so on. So while there may be some Category 3 invalidations with an equally plausible path based on Category 1 art, it seems unlikely there are many Category 3 invalidations with an equally plausible path based on Category 2 art.

169 This number (and all those that follow in the main text of this section) excludes the 6% of anticipation events for which we could not determine the prior art underlying the court's determination. See *supra* Figure 2. We cannot predict how these cases of unknown prior art might affect our results, but the magnitude of any effect would be small.

FIGURE 8: ANTICIPATION BY CITED REFERENCES

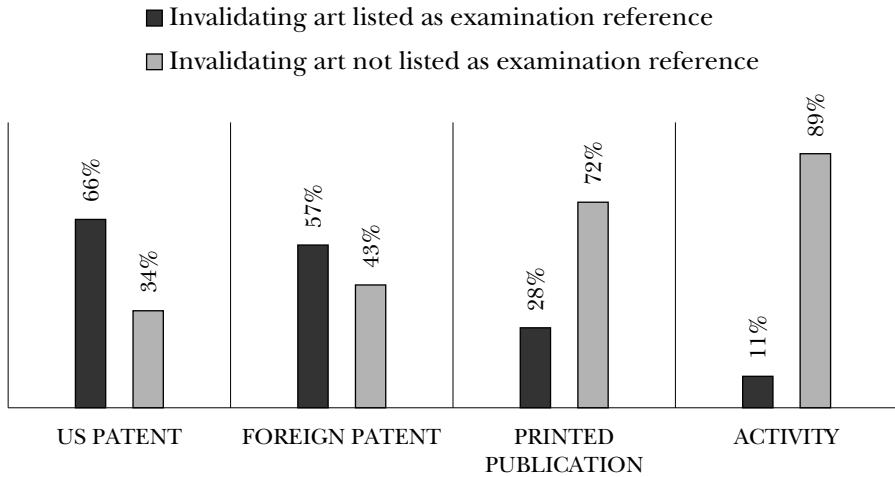


Figure 8 illustrates the percentage of anticipation events relying on prior art known to the examiner, broken down by category of prior art. Invalidation based on a U.S. patent was particularly likely to fall into Category 1—in fully two-thirds of these anticipation events, the anticipating prior patent was listed on the face of the focal patent. When foreign patents were the relevant art, they were known to the examiner in over half the cases. Preventing the issuance of these invalid claims would not require examiners to find art they are currently missing; rather, it would require them to read and understand the prior art they already have.

At first glance, it may seem that anticipating printed publications were rarely known during examination—only 28% of these invalidations are in Category 1. However, it is useful to further divide this category between reference publications (things one might find in a library, such as books, journals, and industry standards) and nonreference publications (items not typically found in a research library, such as catalogs, product manuals, and publications in the “other” category defined in Section III.C). When anticipation was based on prior art in the “reference publication” category, that art was known to the examiner about 45% of the time. By contrast, when anticipation was based on prior art in the “nonreference publication” category, that art was known to the examiner only 10% of the time. Activity prior art was similar to this latter subcategory. When anticipation was based on activity, it was listed on the face of the patent only about 11% of the time.¹⁷⁰

¹⁷⁰ In some of these cases, it is possible that the PTO may have had a patent reference or printed publication that disclosed essentially the same thing as the activity prior art. The substantive equivalence of the activity and the written prior art reference would not always be apparent on the face of the documents we examined, so it is possible that this number undercounts some cases in which the examiner *did* have the relevant art before her.

This gets to a more discouraging point about the prospect of examining for anticipation: the vast majority of uncited art was in Category 3. Though 30% of anticipation events relied on prior art known to the examiner (i.e., Category 1), only 15%–16% of the remaining invalidations relied on a patent or traditional reference publication (i.e., Category 2).¹⁷¹ The remaining 54%–55% of anticipation events relied on an activity or publication that additional search time would be unlikely to uncover (i.e., Category 3).

Taken at face value, this does not bode well for Frakes and Wasserman's prediction.¹⁷² Perfect appreciation combined with perfect search of all worldwide patents and traditional printed publication would preclude only 45%–46% of district court anticipation events. From this vantage point, a 44% reduction in litigation expenses seems more like a theoretical limit on what unlimited examination time might achieve, rather than the likely result of increasing the average examination time from eighteen hours per application to thirty-six.¹⁷³ While doubling examination time would likely yield some improvement, it seems implausible that it would permit examiners to achieve such perfection.

On the other hand, this data also suggests that Lemley's original 10% prediction was implausibly low. Three times that percentage—30%—of anticipating references can be found right on the face of the patent itself. So even if examiners spent *none* of their additional time searching for new references, instead focusing only on reading known prior art and applying it more carefully, it seems likely that they could have precluded more than 10% of our observed anticipation events.

C. Examining for Obviousness

The other half of the 3320 claim invalidations we observed were based on obviousness. As with anticipation, challengers have strategic incentives to search for and rely on previously unexamined prior art whenever possible. And the ability to invoke multiple references to make an argument for obviousness only gives challengers additional latitude to invoke previously unexamined art, even when the examined art may also have been sufficient basis to invalidate the claim.¹⁷⁴

171 The range of uncertainty here is due to the 6% of anticipation events that cited a publication that defied further classification. See *supra* Figure 4.

172 To be clear, Frakes and Wasserman do not make any predictions at this level of specificity. This is merely an intermediate conclusion on the path to assessing their projection as a whole.

173 See Frakes & Wasserman, *supra* note 151, at 1023.

174 Another complication lurks for patents examined before 2007: in *KSR v. Teleflex*, the Supreme Court relaxed the burden necessary to prove a claim is obvious. See *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 415, 419 (2007). Approximately one-third of the obviousness events in our dataset (541 of 1620 claim invalidations) involved patents that were last examined under pre-*KSR* law but were invalidated under post-*KSR* law. However, this change in law between examination and litigation turns out to have very little explanatory power when it comes to our results. See *infra* note 175.

In light of this, one might expect that there would be hardly any Category 1 invalidations—that is, cases in which district courts find claims obvious based entirely on prior art that was considered during examination. And yet such cases do exist. In about 14% of obviousness events, the district court relied exclusively on prior art cited on the face of the patent.¹⁷⁵ These “same art” obviousness invalidations are dominated by cases in which the court relied on a small number of references—80% of these involved only one or two prior art references in total. This is an intuitive result: it was much more likely that the examiner knew of all the relevant references when a smaller number of references were relevant in the first place.

In the other 86% of cases, the district court relied on one or more references that were unknown at the time of examination:

FIGURE 9: OBVIOUSNESS AND UNCITED ART

■ # of uncited references serving as basis for obviousness

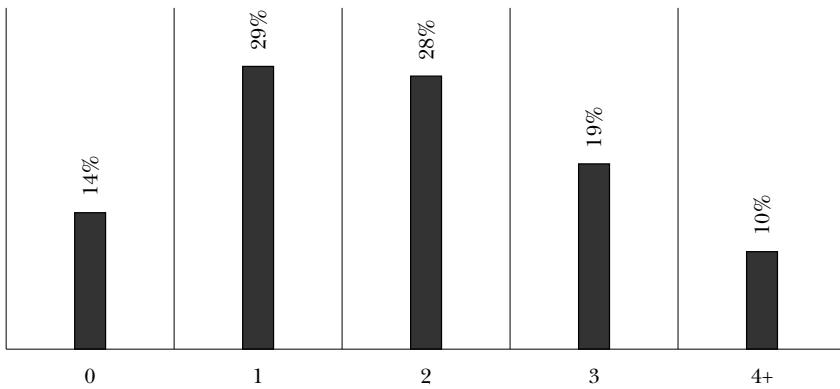


Figure 9 tabulates obviousness events based on the number of references relied on by the court that were uncited in examination. The first column—zero uncited references—corresponds to the 14% of obviousness events in which the court relied exclusively on prior art known to the PTO during examination. By contrast, 29% of obviousness events relied on a single reference unknown to the PTO, and 57% involved two or more such references.

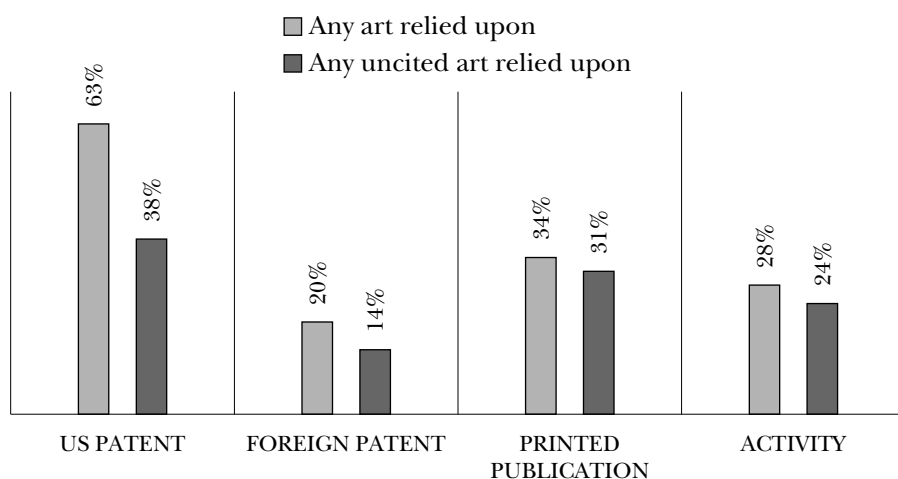
The uncited prior art relied upon by district courts spans the gamut of the prior art categories. Because obviousness invalidations can draw on mul-

¹⁷⁵ This number (and all those that follow in the main text of this Section) excludes the 8% of obviousness events for which we could not determine the prior art underlying the court’s determination. See *supra* Figure 2. We cannot predict how these cases of unknown prior art might affect our results, but the magnitude of any effect would be small.

One might suspect that these invalidations—in which the court found a claim obvious in light of prior art already known during examination—were largely directed at patents examined before the Supreme Court revisited the obviousness standard in *KSR*. See *supra* note 174. This turns out not to be the case: roughly 79% of this group were issued *after KSR*.

multiple references, this data is difficult to summarize concisely. However, one can get a rough sense of the distribution of uncited art in each category:

FIGURE 10: OBVIOUSNESS AND UNCITED ART



The dark gray columns in Figure 10 illustrate the percentage of all obviousness events that rely upon any uncited prior art in each category. For perspective, the lighter columns illustrate the percentage of all obviousness events that rely on any art in that category—cited or uncited. (These are provided for perspective only and should not be used to infer the percentage of art that was cited or uncited within each category.)¹⁷⁶ As Figure 10 shows, there are substantial numbers of uncited references across all prior art categories.

Though Category 1 represents a small share of obviousness invalidations, the good news is that the prior art currently missing in examination is frequently amenable to search. In contrast with anticipation, Category 2 invalidations dominate obviousness in the district court. Somewhere between 45% and 51% of obviousness invalidations relied on art that was unknown during examination, but that missing art was exclusively in the categories of patents or traditional publications.¹⁷⁷ Reliance on unknown and unsearchable prior art was comparatively rare: somewhere between 35% and 41% of obviousness invalidations were in Category 3. In theory, then, perfect search combined

¹⁷⁶ To be clear, comparing those numbers directly would *not* yield the percentage of art cited during examination. For example, suppose that every single obviousness invalidation relied on a pair of printed publications—one cited and one uncited. In that case, the percentage of invalidations relying on any printed publications would be 100% and the percentage of invalidations relying on any uncited printed publications would also be 100%. But it would be wrong to infer that all the invalidating printed publications were uncited.

¹⁷⁷ The range of uncertainty here is due to the 20% of obviousness events that cited a publication that defied further classification. See *supra* Figure 4.

with perfect appreciation could preclude somewhere between 59% and 65% of district court obviousness events.

Compared to anticipation, this increased upper limit makes Frakes and Wasserman's prediction appear somewhat more plausible when it comes to precluding obviousness invalidations. Their estimated 44% reduction in the rate of patent litigation would be just about two-thirds of the theoretical maximum (65%) suggested by our district court invalidity data. Though we cannot rule this out, it certainly seems optimistic.

On the other hand, Lemley's original 10% prediction again appears to err on the side of being too low. A larger share of district court obviousness invalidation (14%) relied only on art already in the examination record. Another 23% of obviousness events could have been precluded by combining known prior art *only* with U.S. patents (a stricter subset of Category 2). In combination, this suggests that perfect appreciation of the most accessible, easily searchable documents could have precluded 37% of obviousness events. As above, we cannot say with certainty how much of these gains could be achieved by doubling examination time. But unlocking even a modest share of them would result in a reduction in litigation exceeding Lemley's prediction.

* * *

In sum, our district court invalidity data suggests that the effects of increasing examination time would fall somewhere in between the two poles staked by prior scholars. On the one hand, Lemley's prediction appears implausibly pessimistic—easily more than 10% of invalidation events could be precluded through basic improvements to patent examination. On the other hand, Frakes and Wasserman's prediction comes uncomfortably close to the apparent limit on the number of district court invalidity events that could be avoided through examination. An exhaustive search of all worldwide patents and traditional publications combined with perfect appreciation of those and other already cited references would preclude between 52% and 55% of all district court invalidations. While we cannot rule a 44% reduction out of hand, it seems quite optimistic to expect a doubling of examination time to come so close to the upper limit.

Our departure from Lemley is easy to explain: as he acknowledged at the time, his 10% figure was simply an assumption, one made to facilitate a calculation exercise in the absence of data.¹⁷⁸ Now that we have some data, it should not come as a surprise that we might reach a different conclusion.

Our distance from Frakes and Wasserman requires a bit more exploration, since their prediction is based not just on data, but on a careful and expansive study of the examination process during a largely overlapping time period.¹⁷⁹ One possible explanation is the "strategic litigant" bias acknowledged above—the possibility that challengers would avoid Category 1 art

178 See Lemley, *supra* note 21, at 1509, 1511–14.

179 See Frakes & Wasserman, *supra* note 151, at 995–98.

when Category 2 or Category 3 art was available as an alternative. But there are several reasons to doubt that this alone would align our predictions. First, reliance on prior art in Category 1 was already surprisingly high, suggesting that litigants' strategic interest in avoiding this category may not be as great as we expected. Second, to alter our predictions, challengers would not only need to be relying on uncited art when cited art was also available, but specifically relying on *activities and nontraditional publications* to the exclusion of cited prior art. (That is, they would need to be choosing Category 3 art over Category 1 art, not just dispreferring Category 1 in general.) Though this is certainly possible, we note that there are counterbalancing doctrinal hurdles to qualifying activity and nontraditional publications as prior art. From a challenger's point of view, these might offset the strategic benefits of invoking uncited prior art.¹⁸⁰ Finally, the effect of this "strategic litigant" bias would have to be quite large before Frakes and Wasserman's prediction ceases to look optimistic. Suppose, for example, that 10% of all our observed invalidations were reclassified from Category 3 to Category 1. That would make somewhere between 62% and 65% of patent litigation *potentially* avoidable through examination. Nonetheless, Frakes and Wasserman's estimate of a 44% reduction in patent litigation would nonetheless constitute two-thirds of the preclusion available by combining perfect search with perfect appreciation.

A more plausible explanation for our divergence from Frakes and Wasserman is that we are predicting two subtly different things. Strictly speaking, Frakes and Wasserman's 44% estimation is based on the relationship between investment in examination and case filings.¹⁸¹ They then assume that the percentage of cases reaching a given stage (for example, close of discovery, claim construction, summary judgment, trial, etc.) would remain the same.¹⁸² Our data, by contrast, observes litigation at a very late stage in the process—when the court actually finds a claim invalid. One way of reconciling our predictions, therefore, is to expect that the court cases precluded by increasing examination time will disproportionately be ones that would have ended at an early stage anyway. This would make it possible for *case filings* to go down 44% as Frakes and Wasserman predicted, with *decisions of invalidity* going down by a more modest percentage.

This complication has two important consequences. First, the cost of litigation increases the further it progresses. So if it is true that the cases avoided by doubling examination time will tend to be ones that would have ended at an early stage anyway, that will reduce the predicted cost savings obtained by making this additional investment in examination. Given that Frakes and Wasserman's quantified cost-benefit case for doubling examina-

180 See *supra* notes 127–28 and accompanying text.

181 Frakes & Wasserman, *supra* note 151, at 995–96.

182 Avoidance of litigation proceeding to claim construction accounts for about 24% of Frakes and Wasserman's predicted cost savings, while avoidance of litigation proceeding to trial accounts for about 16%. Michael D. Frakes & Melissa F. Wasserman, *Irrational Ignorance at the Patent Office*, 72 VAND. L. REV. 1, online app. at 17 tbl.A7 (2019).

tion time hangs by a rather slim margin,¹⁸³ this reduction in predicted benefits could imperil the case for the additional investment. Alternatively, it may require specification of other expected benefits in order to justify the increased expenditure.

Second, this complication affects how we should measure the success of Frakes and Wasserman's proposal, should it be implemented. If the PTO increases examination time, we should expect to see a significant reduction in the number of patent cases filed some years down the road. But we should not be surprised if the number of patents invalidated in court annually remains a more resilient figure.

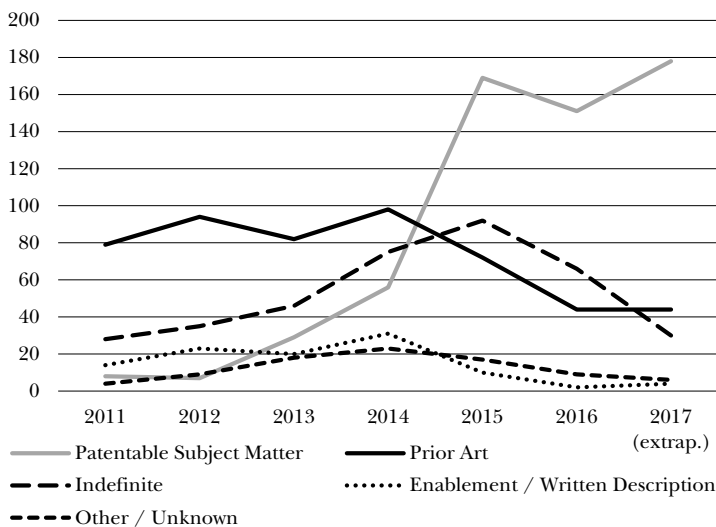
V. REASONS FOR INFERENTIAL CAUTION AND FUTURE WORK

A risk for any study of this type is that observations of the past may fail to accurately predict the future. This Part briefly discusses several ways in which the patent system was observed to be changing during the study period and introduces related questions requiring further study.

A. Invalidity Basis Is Changing Over Time

The first trend that must be noted is that the legal basis for judicial invalidation of issued patents changed dramatically between 2011 and 2017. While the ratio of anticipation events to obviousness events remained stable,¹⁸⁴ the rates of both forms of invalidity have declined overall, particularly compared to other legal grounds:

FIGURE 11: PATENT-LEVEL INVALIDITY EVENTS



183 See Frakes & Wasserman, *supra* note 151, at 1021.

184 See *supra* Section III.A.

Figure 11 illustrates the number of patent-level invalidity events per year by legal basis. For ease of representation, anticipation and obviousness are grouped into a single category, “Prior Art.” Written description and enablement are also represented in a single merged category. Data for the end of 2017 is extrapolated based on the first six months of 2017.

Most importantly for this study, the number of patents invalidated on anticipation or obviousness grounds has fallen dramatically over the last several years. From 2011 to 2014, between 80 and 100 patents per year experienced invalidity based on prior art. This number slid to 72 in 2015 and was down to just 44 in 2016. Moreover, district courts appeared to be on track to invalidate about 44 patents on prior art grounds in 2017. In other words, over the course of the study period, the rate of anticipation and obviousness invalidations fell off more than 50%.

There are several potential explanations for this decline. One is that patents vulnerable on prior art grounds are instead being invalidated on a different legal basis. As Figure 11 shows, invalidations related to patentable subject matter¹⁸⁵ surged around 2014, and invalidations based on indefiniteness¹⁸⁶ also briefly peaked in 2015. (These trends correspond with several major Supreme Court cases in those areas handed down around the same time.)¹⁸⁷ Another possible explanation for the decline in anticipation and obviousness invalidations is that the new administrative challenge procedure called inter partes review (IPR) has partially displaced the role of courts in this area. The first IPR petitions were accepted on September 16, 2012, and, by the end of the study period, IPR had become an important tool for challenging patents on prior art grounds. In both 2015 and 2016, around 380 patents per year experienced prior-art-based invalidations in IPR proceedings.¹⁸⁸ Either explanation could plausibly account for the thirty to forty annual prior art invalidity events that went missing from district courts during the same time period.

Whatever the cause, the trends reflected in Figure 11 may, over time, also affect the composition of prior art relied upon in district courts. For example, the surge in patentable subject matter invalidations has had a devastating effect on patents for software and medical diagnostics, at least in the short term. If anticipation or obviousness invalidations in those fields were particularly likely to draw on art of one type or another, the overall picture of prior art in district court may change as well. We do not yet have enough

185 See 35 U.S.C. § 101 (2012).

186 See 35 U.S.C. § 112 (2012).

187 See *Alice Corp. v. CLS Bank Int’l*, 134 S. Ct. 2347, 2352, 2355, 2358 (2014) (changing law of patentable subject matter for “abstract ideas”); *Nautilus, Inc. v. Biosig Instruments, Inc.*, 134 S. Ct. 2120, 2124 (2014) (changing law of definiteness); *Mayo Collaborative Servs. v. Prometheus Labs., Inc.*, 566 U.S. 66, 70–73 (2012) (changing law of patentable subject matter for “laws of nature”).

188 IPR proceedings invalidated 381 patents on anticipation or obviousness grounds in 2015. In 2016, the number was 386. This data is courtesy of Lex Machina. LEX MACHINA, *supra* note 87.

data to test for this possibility or predict its effects. Therefore, future studies will be necessary to determine whether the composition of prior art in the district court is changing as a result of these trends.

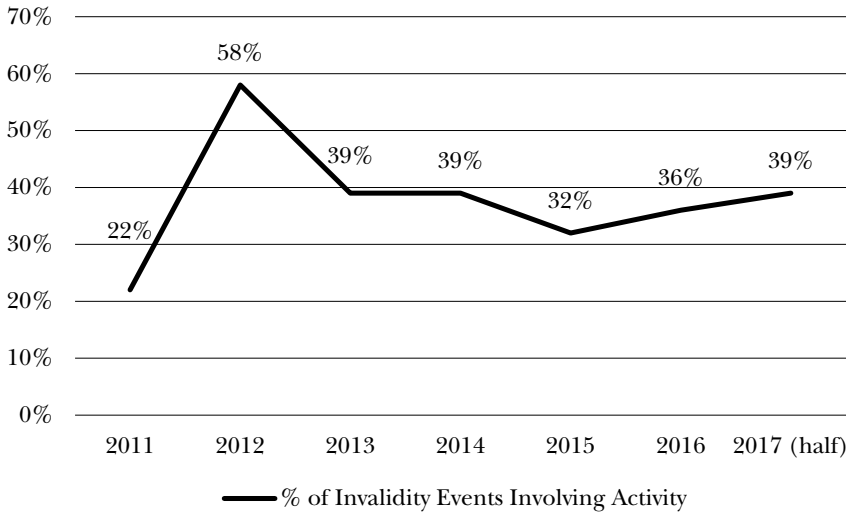
B. IPR Selection Effects

While we cannot determine how much of the decline of district court anticipation and obviousness invalidations is attributable to IPR, we *can* test one theory of how IPR might be affecting district courts. By statute, IPR challenges can be based only on patents or printed publications.¹⁸⁹ A challenger seeking to invalidate a patent based on activity prior art must therefore proceed to district court, while a challenger drawing only on patents and printed publications may proceed in either IPR or the district court.¹⁹⁰

IPR is cheaper than district court litigation and offers a number of procedural advantages for patent challengers.¹⁹¹ Therefore, one might expect to see a reverse selection effect in district courts following the advent of IPR: a decline in the number of anticipation and obviousness invalidations overall, coupled with an *increase* in the percentage of invalidations relying on activity.

While the number of district court anticipation and obviousness invalidations has fallen in recent years, the second part of this prediction has not materialized. Indeed, there has been no noticeable increase in the percentage of district court cases relying on activity prior art:

FIGURE 12: ACTIVITY PRIOR ART IN DISTRICT COURT



189 35 U.S.C. § 311(b) (2012).

190 Activity prior art *is* admissible in a different administrative challenge proceeding called “post-grant review.” *See id.* § 321(b). However, post-grant review is only available for recently filed patents, and only then for the first nine months following issuance. *See id.* § 321(c).

191 *See* Gregory Dolin, *Dubious Patent Reform*, 56 B.C. L. REV. 881, 919–20 (2015).

Figure 12 illustrates the percentage of patent-level invalidity decisions relying on activity prior art.¹⁹² A decision is counted as relying on activity prior art if it cites activity prior art to support the invalidation of *any* claim, whether for purposes of anticipation or obviousness. As Figure 12 shows, this number has remained remarkably stable throughout the advent of IPR. There is no evidence of the reverse selection effect one might have predicted.

This does not eliminate the possibility that IPR may be having an effect on the composition of cases litigated to a decision in district court. But whatever the interaction is, it has not resulted in the straightforward increase in activity-based invalidations in court that one might have expected.

C. Changes in Prior Art Rules

Finally, it is also important to note that the 2011 America Invents Act (AIA) made several changes to the prior art rules,¹⁹³ and these changes could affect the kinds of prior art district courts rely upon in the future. The new prior art rules apply based on an application's effective filing, so the rule changes had no immediate effect on existing patents.¹⁹⁴ Because almost all of the invalidation events in this study involved applications of the pre-AIA law, we must consider the possibility that applications of post-AIA law may rely on different kinds of prior art.

The most significant reform in the AIA was the move from a first-to-invent to a first-to-file system.¹⁹⁵ Though this was obviously an important change for patent prosecutors and litigators, it is not clear whether it will have any effect on the kinds of prior knowledge and activities that ultimately qualify as prior art. Even if it does have such an effect, it is not clear in which direction it would operate.

Aside from the change to first-to-file, the AIA made some subtle adjustments in the rules for what may qualify as activity prior art. The geographic limitation that the invalidating public use or sale must occur within the United States was eliminated,¹⁹⁶ which would tend to make it easier for art to qualify in those categories. At the same time, the AIA amendments eliminated the "prior invention by another" prior art path.¹⁹⁷ It is too soon to make any predictions whether, on net, activity prior art will become more or less prominent in district court going forward.

192 The units of analysis here are patent-decisional document combinations—a single court decisional document invalidating two patents would correspond to two observations, as would two decisional documents involving the same patent.

193 Leahy-Smith America Invents Act, Pub. L. No. 112-29, 125 Stat. 284 (2011) (codified at 35 U.S.C. § 102 (2012))

194 *Id.* § 3(n)(1).

195 *Id.* § 3.

196 Robert P. Merges, *Priority and Novelty Under the AIA*, 27 BERKELEY TECH. L.J. 1023, 1027 (2012).

197 It appears that few district court decisions will be affected by the removal of this prior art path. See *supra* notes 126–32 and accompanying text.

This raises a more general point. The possibility of future legal change is an unavoidable, inherent risk for a study of this kind. We cannot rule out the possibility of future legislation or overruling of precedent that may have a significant effect on how district courts rely on prior art in the future. There is nothing we can do besides acknowledge this risk and plan for further study.

CONCLUSION

Overall, district court litigation outcomes present a mixed picture when it comes to the questions of interest in this study. At both a claim and patent level, invalidations appear to be consistently balanced between anticipation and obviousness. The former group bears many of the indicia of publicly beneficial error correction. A high percentage of anticipation invalidations involve the plaintiff or defendant's own prior work, and it appears that reliance on obscure prior art is quite rare.

The same conclusions do not appear to hold for cases of obviousness. A significant number of obviousness invalidations rely on obscure prior art, suggesting that they may be less likely to provide incentivizing error correction. However, current policies encouraging testing of obviousness may nonetheless be defensible on other grounds and will require further study.

Finally, the case for increasing examination scrutiny remains ambiguous. While the volume of patent litigation that could be precluded by more examination time appears to be larger than has been previously assumed, it is likely smaller than other scholars have recently predicted. Reforms to increase examination resources may yet be justified on other grounds, but it does not appear that increased examination expenditure can be justified through litigation savings alone.