Does *Alice* Target Patent Trolls?[1]

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The Supreme Court upended the patent world in the past decade with a series of decisions restricting the scope of patent-eligible subject matter.[4] The culmination of those cases – *Alice v. CLS Bank*[5] -- has been at the center of a firestorm of controversy in the five years since it was decided. *Alice* has been the target of efforts at legislative reform and multiple petitions to the Supreme Court, the focus of multiple inconsistent waves of guidance from the Patent and Trademark Office (PTO), and the subject of countless conferences, panels, and legal advice letters. As we show in this paper, it has also been the basis of nearly a thousand court decisions.

We evaluate how *Alice* and similar Supreme Court decisions on patentable subject matter have been used in the courts five years in. Using a comprehensive

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4 Association for Molecular Pathology v. Myriad Genetics, 133 U.S. 2107 (2013); Mayo Collaborative Services LLC v. Prometheus Laboratories, Inc., 566 U.S. 66 (2012); Bilski v. Kappos, 561 U.S. 593 (2010).

5 Alice Corp. v. CLS Bank International, 573 U.S. 208 (2014).

dataset we hand-coded of every district court decision and subsequent appeals to the Federal Circuit involving patentable subject matter,[6] we explore not only how patent owners fare in patentable subject matter cases but how a variety of factors, including industry, the nature of the patent owner, and the judicial venue may influence those results. While we confirm some conventional wisdom, we upend other assumptions common in the legal and policy debates over patent eligible subject matter. In particular, we find that once in court, biotech/life science innovations are more likely to survive patentable subject matter challenges than software/IT innovations. Most surprisingly we find that the entities most likely to lose their patents at this stage are not patent trolls but individual inventors and inventor-started companies. Our findings have important implications for current legislative and judicial disputes over patent reform. As biotech worries about deterrence of new innovation and software worries about patent trolls dominate the debates, we may be ignoring some of the most important effects of *Alice*.

We briefly set the background in Part I. We describe our methodology in Part II and our results in Part III. In Part IV we offer some thoughts about implications of this data.

[6] We also collect data on Federal Circuit appeals from PTAB decisions, but we exclude them from most of our analysis here.

I. The Patentable Subject Matter Controversy

To be valid, a patent must meet several substantive requirements, including being new, nonobvious, and adequately described.[7] But if it does, the universe of things potentially patentable has historically been broad. The statute says patents can cover any new and useful "process, machine, manufacture, or composition of matter."[8] Read literally that list is not restrictive, extending to "anything under the sun made by [people]."[9] For nearly two centuries, however, courts have held that certain things are outside the proper scope of patent law. Among those excluded categories are abstract ideas, laws of nature and natural phenomena, products of nature, printed matter, mental steps, and (sometimes) business methods.[10]

The Supreme Court largely left the field of patent law for decades after the creation of the Federal Circuit in 1982 – the court with exclusive jurisdiction over

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7 35 U.S.C. §§102, 103, 112.

8 35 U.S.C. §101.

9 S. REP. NO. 1979, at 5 (1952); H.R. REP. NO. 1923, at 6 (1952) ("A person may have 'invented' a machine or a manufacture, which may include anything under the sun that is made by man, but it is not necessarily patentable under section 101 unless the conditions of [this] title are fulfilled.").

10 Diamond v. Diehr, 450 U.S. 175, 185 (1981) ("This Court has undoubtedly recognized limits to § 101, and every discovery is not embraced within the statutory terms. Excluded from such patent protection are laws of nature, natural phenomena, and abstract ideas." citing Parker v. Flook, 437 U. S. 584 (1978); Gottschalk v. Benson, 409 U.S. 63 (1972), and Funk Bros. Seed Co. v. Kalo Inoculant Co., 333 U. S. 127 (1948)). Mark A. Lemley et al., *Life After Bilski*, 63 STAN. L. REV. 1315, 1318 (2011) citing *In re* Bilski, 545 F.3d 943 (Fed. Cir. 2008) (en banc) ("…even if a [business method] meets [the machine-or-transformation test], it is unpatentable if the machine or transformation is merely incidental extra-solution activity. And an invention that preempts all use of a law of nature or algorithm, even in a particular field of use, is not patentable even if it would otherwise survive the test.").

patent appeals.[11] In 1998, the Federal Circuit effectively did away with patentable subject matter limitations, extending patents to anything in any form that produced a "useful result," even a result that was just a number.[12] Patentable subject matter was then dormant for a decade, and the PTO issued – and courts enforced – patents in all fields.

Beginning in 2010, however, the Supreme Court returned to the doctrine.[13] In a series of four decisions over a five-year period, the Supreme Court made clear that patentable subject matter limits were alive and well.[14] In the most recent decision, *Alice*, the Court confirmed a two-step test for determining whether a claim was patentable: (1) is the claim "directed to" an abstract idea, law of nature, or other excluded subject matter? and (2) if so, does the claim include an inventive step beyond merely the claimed abstract idea or natural phenomenon?[15]

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11 Mark A. Lemley et al., *Life After Bilski*, 63 STAN. L. REV. 1315, 1318 (2011) ("For a decade after 1998, patentable subject matter was effectively a dead letter. That changed dramatically in 2008 when the Federal Circuit decided *In re* Bilski en banc.").

12 State St. Bank & Trust Co. v. Signature Fin. Grp., 149 F.3d 1368, 1373 (Fed. Cir. 1998).

13 This return occurred against the backdrop of the PTO issuing broad software patents that then were enforced by patent assertion entities (PAEs) and patents on core biological innovations that have the potential to block follow-on research and the scholarly reaction to those changes. *See* Dan L. Burk & Mark A. Lemley, THE PATENT CRISIS AND HOW THE COURTS CAN SOLVE IT (2009); Michael Heller & Rebecca S. Eisenberg, *Can Patents Deter Innovation? The Anticommons in Biomedical Research*, 280 SCI. 698 (2008); Paul Gugliuzza *The Procedure of Patent Eligibility*, 97 TEX. L. REV. 571, 573 (2019).

14 Association for Molecular Pathology v. Myriad Genetics, 133 U.S. 2107 (2013); Mayo Collaborative Services LLC v. Prometheus Laboratories, Inc., 566 U.S. 66 (2012); Bilski v. Kappos, 561 U.S. 593 (2010), Alice Corp. v. CLS Bank International, 573 U.S. 208 (2014).

15 Alice Corp. v. CLS Bank International, 573 U.S. 208 (2014).

The result was a dramatic increase in patentable subject matter litigation, which had dropped nearly to zero after *State Street*.[16] That litigation happened primarily in the biomedical industries, particularly against gene patents and medical diagnostics, and in the software and business method fields.[17] Courts have struggled to apply the two-part *Alice* framework, coming to decisions that are arguably inconsistent and causing many judges and lawyers to throw up their hands and say that the ensuing case law is impossible to understand or apply.[18] The twelve-judge Federal Circuit split 7-5 in a recent patentable subject matter case that produced eight different opinions.[19]

Not surprisingly, a large number of patent owners are unhappy that their patents are being invalidated under a theory that effectively didn't exist a decade ago. The confusion – and maybe the substantive change – have led to calls for reform. The Senate held a series of hearings in 2019 on legislation that would overrule not just *Alice*, but the entire suite of judicially-created exceptions to

16 John R. Allison et al., *Understanding the Realities of Modern Patent Litigation*, 92 TEX. L. REV. 1769, 1782 (2014) ("There are a growing number of decisions based on patentable subject matter … a category of minor importance in the 1998 study.").

17 *See* infra Section III.B.

18 Paul R. Michel, *The Supreme Court Saps Patent Certainty*, 82 GEO. WASH. L. REV. 1751, 1758 (2014) ("[the categories for patent eligibility] tend to be subjective … indeterminate … [and] highly unpredictable, which leads to… difficulty advising clients, people knowing what to do, how to act."); David O. Taylor, *Confusing Patent Eligibility*, 84 TENN. L. REV. 157, 158 (2016) (noting that the current confusion in patent law "exists because the current approach to determining patent eligibility confuses the relevant policies underlying numerous discrete patent law doctrines, and because the current approach lacks administrability.").

19 Athena Diagnostics, Inc. v. Mayo Collaborative Services, LLC 915 F.3d 743 (Fed. Cir. 2019).

patentable subject matter.[20] The PTO issued guidelines in January 2019 that effectively instructed patent examiners to ignore Federal Circuit caselaw.[21] In response, the Federal Circuit held that it wasn't bound by the PTO's interpretation of the law.[22] The Supreme Court asked the Solicitor General of the United States whether it should take two new patentable subject matter cases.[23] In response, the SG said that they should not take those cases, but should instead take *Athena* and use it as a vehicle to rewrite its caselaw altogether.[24] The Supreme Court subsequently declined to take *Athena* or any other case on patentable subject matter.[25]

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[20] The State of Patent Eligibility in America: Hearing Before the Subcommittee on Intellectual Property, 116 Cong. (June 4, 5, and 11, 2019).

[21] United States Patent and Trademark Office, 2019 Revised Patent Subject Matter Eligibility Guidance, 84 Fed. Reg. 50 (Jan. 7, 2019).

[22] Cleveland Clinic Foundation v. True Health Diagnostics, LLC, 760 Fed.Appx. 1013, 1020 ("While we greatly respect the PTO's expertise on all matters relating to patentability, including patent eligibility, we are not bound by its guidance.").

[23] HP, Inc. v. Steven E. Berkheimer, 139 S.Ct. 860 (Mem); Hikma Pharm. USA Inc. v. Vanda Pharm., 139 S.Ct. 1368 (Mem).

[24] Brief for the United States as Amicus Curiae, HP, Inc. v. Steven E. Berkheimer, --- S.Ct. ----, 2020 WL 129532 (Mem) (brief at No. 18-415, 2019 WL 6715368 (U.S. December 6, 2019); Brief for the United States as Amicus Curiae, Hikma Pharm. USA Inc. v. Vanda Pharm., --- S.Ct. ----, 2020 WL 129534 (Mem) (brief at No. 18-817, 2019 WL 6699397 (U.S. December 6, 2019)).

[25] Athena Diagnostics v. Mayo Collaborative Servs., 140 S. Ct. 855 (Mem) (cert. denied Jan. 13, 2020).

II. What We Did

A. Building the Case Database

Against this backdrop, we set out to study how *Alice* actually affected patentable subject matter decisions issued by district court and Federal Circuit judges. We began by collecting all U.S. District Court and Federal Circuit decisions in Westlaw[26] that cited either 35 U.S.C. §101 or *Alice* or *Mayo* after June 2014 through June 2019.[27] We removed all duplicates, resulting in an over inclusive initial list of 1,395 decisions. However, Westlaw is known to have incomplete, and non-representative, information on non-published opinions,[28] requiring us to supplement this initial list with several additional sources.

Alice has been the subject of considerable debate and practical confusion over the last five years,[29] providing a number of law firms and academic scholars worthwhile reasons to keep track of patent eligibility decisions and their outcomes in the courts. We supplemented our Westlaw list with a number of these publicly

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[26] Westlaw Edge, owned by Thomson Reuters, available at: https://lawschool.westlaw.com/. We also used the Westlaw Patent Act Section 101: Case Tracker by Practical Law Intellectual Property & Technology available at: https://1.next.westlaw.com/Document/I9f033f0b194411e798dc8b09b4f043e0/View/FullText.html?contextData=(sc.Default)&transitionType=Default), but this list did not reveal any decisions not already in our searches.

[27] *Alice* (Alice Corp. v. CLS Bank Int'l, 573 U.S. 208 (2014)) was decided on June 19, 2014. We included all decisions after that date through June 2019 to capture five full years of data. We additionally searched for *Mayo* (Mayo Collaborative Services LLC v. Prometheus Laboratories, Inc., 566 U.S. 66 (2012)) to ensure we were including all life science cases.

[28] See Christopher B. Seaman, *Permanent Injunctions in Patent Litigation After EBay: An Empirical Study*, 101 IOWA L. REV. 1949, 1973 and note 157 (2016) ("…commercial electronic databases like LexisNexis and Westlaw … may not be representative…").

[29] *See* supra Part I.

available lists from Fenwick & West,[30] Fish & Richardson,[31] BitLaw,[32] and Gibson Dunn.[33] Together, these sources added another 62 decisions, with Gibson Dunn providing the most comprehensive list.

The RPX Corporation, a private patent risk management company, also has compiled a list of patent eligibility decisions that cite *Alice* in the course of their business.[34] They were willing to share their list of decisions and outcomes to verify the data used in this article. The majority of our lists overlapped, but the RPX list added another 7 decisions ours had not captured.

In order to find any remaining unpublished district court decisions, we conducted searches on Lex Machina.[35] Lex Machina, a comprehensive database of U.S. patent and other intellectual property litigation, compiles information and documents from the PACER docketing system and associates searchable tags with

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30 Fenwick & West LLP Patent Eligibility Case Analysis Tool available at: https://www.fenwick.com/pages/post-alice.aspx.

31 Fish & Richardson LLP Alice Tracker available at: https://www.fr.com/alice-tracker/.

32 BitLaw Section 101 Court Cases Table available at: https://www.bitlaw.com/patent/section-101-cases.html.

33 The Gibson, Dunn & Crutcher LLP Chart of Post Alice Cases as of March 1, 2019 is available at: https://bit.ly/2LPIE8F. It is a supplement to Jasper L. Tran & J. Sean Benevento, Alice at Five, 2019 Patently-O Patent Law Journal 25 (https://cdn.patentlyo.com/media/2019/11/Tran.2019.AliceatFive.pdf).

34 RPX uses their proprietary in blog posts like "Alice Turns Five" on June 19, 2019 (https://www.rpxcorp.com/data-byte/data-byte-alice-turns-five/); "Q2 in Review: Alice Reined In as Invalidation Rate Drops, While Patent Litigation Picks Up" on July 9, 2019 (http://www.rpxcorp.com/intelligence/blog/q2-in-review-alice-reined-in-as-invalidation-rate-drops-while-patent-litigation-picks-up/); and "Patents Invalidated Under Alice Before and After Berkheimer by Procedural Stage" on Sept. 25, 2019 (https://www.rpxcorp.com/data-byte/patents-invalidated-under-alice-before-and-after-berkheimer-by-procedural-stage/).

35 Lex Machina is owned by LexisNexis and provided research access to the database for this article. The data is available at https://law.lexmachina.com/.

each case. Because Lex Machina pulls directly from PACER, it is possible to find non-published patent eligibility decisions using key terms and the searchable tags.[36] We added 96 unpublished decisions from Lex Machina that were not already included from other sources.

Finally, although Federal Circuit decisions are widely available, many are affirmances with no written opinion, allowed under Federal Circuit Rule 36, but still important for understanding judicial decisions.[37] Because Rule 36 decisions have no written opinion, they will not appear in keyword searches. To ensure we did not miss any such decisions in patent eligibility cases, we supplemented our database with all Federal Circuit patent eligibility decisions found by Gugliuzza and Lemley in their Federal Circuit post-Alice 101 Decisions database, which is current through March 2018.[38] To find Federal Circuit Rule 36 opinions for patent

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[36] We conducted six separate, over inclusive searches for relevant patent eligibility cases in Lex Machina: (1) Patent cases with keywords [("Alice" OR "Mayo")] with No Invalidity as a Patent Finding; (2) Patent cases with keywords [("section 101" ~ 3) OR ("USC 101" ~ 3)] with No Invalidity as a Patent Finding; (3) Patent cases with keywords [("Alice" OR "Mayo")] with Invalidity as a Patent Finding; (4) Patent cases with keywords [("section 101" ~ 3) OR ("USC 101" ~ 3)] with Invalidity as a Patent Finding; (5) Patent cases with keywords [("Alice" OR "Mayo") AND (("section 101" ~ 3) OR ("USC 101" ~ 3))]; and (6) Patent cases with Invalidity as a Patent Finding and 101 Subject Matter as a Patent Invalidity Reason. These searches resulted in patent eligibility cases dispositive decisions either found the patent claims invalid or valid or found that a determination would be premature at the current stage in the proceedings.

[37] See Paul R. Gugliuzza and Mark A. Lemley, *Can a Court Change the Law By Saying Nothing?* 71 VANDERBILT L. REV. 765, 767 and note 2 (2018) ("Including Rule 36 affirmances is essential to providing an accurate empirical analysis of the Federal Circuit's decisionmaking practices").

[38] Paul R. Gugliuzza and Mark A. Lemley, *Can a Court Change the Law By Saying Nothing?* 71 Vanderbilt L. Rev. 765, 811 (2018) (Appendix A). The cases have been updated from July 2014 through March 2018, available at: https://docs.google.com/spreadsheets/d/1b5HL66qJG3B1N2qi9EKZuVhl0R2TUX9J2EnHUq3clQc/edit#gid=0.

eligibility cases after March 2018 through June 2019, we pulled all 347 Federal Circuit Rule 36 opinions from the official Federal Circuit website[39] and then used Westlaw to trace the history of the opinion. Those linked to a patent eligibility case were included. We added 103 Federal Circuit decisions through this process and the list from Gugliuzza and Lemley.

Our working database contains 1,663 decisions in the district courts and Federal Circuit from July 2014 through June 2019 that were likely to have ruled on patent eligibility. However, several of our searches in Westlaw and Lex Machina were intentionally over inclusive, so we proceeded to manually review each decision to determine whether it provided an outcome on a patent eligibility challenge or whether it only mentioned *Alice/Mayo* or Section 101 in passing. We removed decisions that only mentioned *Alice/Mayo* or Section 101 without resolving a substantive patentable subject matter issue and decisions not directly making a new ruling on the patent eligibility of a particular patent.[40] Since we chose to focus here on judicial decisions made in the district courts and their appeals we also removed 39 PTAB cases on 101 that were appealed to the Federal Circuit.[41] We

[39] U.S. Court of Appeals for the Federal Circuit, Opinions & Orders available at: http://www.cafc.uscourts.gov/opinions-orders.

[40] To avoid over counting the same functional decision and to consistently treat situations where one decision was applied to multiple cases on the same patents, we removed decisions that did not provide a ruling because the patent had already been invalidated in a parallel case. We only counted a decision once if it was applied in the same way for the same patent in multiple cases. We also removed magistrate reports and only considered the judge's ruling in such situations. Since we are only interested in studying district court and Federal Circuit decisions, we also removed a small number of decisions in the U.S. Court of Federal Claims, U.S. District Court for DC, and the U.S. Court of Appeals for the DC Circuit.

[41] Although 101 challenges occur in the PTAB and appeals from such cases appear on the Federal Circuit docket, the types of cases, patents, and parties are likely to be different from

retained 860 unique district court and Federal District decisions on patent eligibility after *Alice*. None of the external lists we used to verify our database contained all of these decisions, so ours may be one of the most comprehensive lists currently available.[42]

Although our data set represents almost the entire population of court cases with decisions on patent eligible subject matter challenges after *Alice*, implications that can be drawn from the data are subject to a number of limitations. First, our data is directed towards litigation, not administrative challenges to existing patents or PTO rejections of patent applications on patentable subject matter grounds.[43] For example, it is possible that different types of patents and patent asserters appear before the PTAB, and it is certain that the PTAB hears different substantive challenges. Not only can our paper not be extended to PTAB decisions, but it does not allow us to draw any conclusions about the selection of cases into the PTAB versus the district courts.

Second, our data set only includes cases where there was a patentable subject matter eligibility challenge and dispositive decision from July 2014 – June 2019.

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those appearing in the district courts. Some are ex parte appeals from the denial of a patent application and do not involve an issued patent at all. Those that do are limited to "Covered Business Method Review," a limited proceeding that applies only to certain financial services patents. To isolate the decision patterns of 101 cases that appear in the district courts and their associated appeals in the Federal Circuit, we chose to drop any appeals from the PTAB in our analyses. To the extent that different types of patents are rejected or invalidated in the PTAB rather than in an infringement lawsuit, our data will not fully reflect them.

42 The database and STATA code for the analyses in this paper is available at _____[TBA].

43 Challengers cannot bring IPR proceedings based on patentable subject matter. There is a limited provision permitting challenges to "covered business method patents" on patentable subject matter grounds. 35 U.S.C. § 321(b).

Because of this, our data will not allow us to draw conclusions about what happens in cases that settle prior to a decision on such a challenge. This includes cases that never come to court, those where the parties settle before bringing a Section 101 challenge, and those that settle after bringing a Section 101 challenge but before a dispositive decision. Our data can only be used to show what is likely to happen once parties get far enough along in their suit to face at least a preliminary decision on a Section 101 challenge. We can't use our data to say what would happen when a new case is filed. Further, the direction of the bias is unclear if we wanted to extrapolate to all filed patent cases with a Section 101 challenge. It could be the case that more settlements happen when the patents at issue are likely to survive the challenge. This would likely raise the rates of patent eligibility above those reported here. Alternatively, more settlements could be occurring with weaker patents that are not likely to survive an eligibility challenge, echoing a fear of "trolls" that bring nuisance suits to encourage settlements. This would increase our reported invalidity rate.

Third, our data describes the state of patent eligibility decisions for the five years after *Alice*, but our models may not accurately predict the outcomes for future 101 decisions in new cases. As 101 challenges become more common, the courts will adjust their application of *Alice*, as they did in *Berkheimer*,[44] and patent asserters may choose to bring different types of cases in response to the changes in law. As

[44] Berkheimer v HP Inc., 881 F.3d 1360, 1370 (2018).

this shift occurs, the population of cases involving a 101 challenge may differ from the population of cases we capture here.

Finally, we only attempt to describe the current state of patentable subject matter eligibility decisions to highlight any differences between the policy debates and actual use in the courts. Our results show relationships between decision outcomes and several different factors however, they should not be interpreted as causal. Because of these limitations, our conclusions and implications reflect our focus on judicial decisions in the five years after *Alice*, but should not be extrapolated to other invalidations without caution.

B. Key Variable Descriptions

a. Invalidity Outcomes

Our main dependent variable of interest is whether or not a decision determines that a patent is invalid on patentable subject matter grounds. We manually coded each patent eligibility outcome as *Eligible* (the court ruled in favor of the patent asserter), *Ineligible* (the court ruled in favor of the challenger), or *Premature* (the court deemed the validity challenge too early in the proceedings).[45] Where possible, we used the outcomes reported by the third party lists of 101

[45] It is not always clear when the court rules that a patent is eligible versus when it concludes the challenge is premature. If the decision states that there are still material facts at issue or that it is too early in the proceedings and another 101 challenge can be filed later, then we consider those decisions premature.

decisions to independently verify our coding. In cases of disagreement, we carefully re-read the decision to determine where the discrepancy originated.[46]

In some of our results, we simplify the coding to only include two possible outcomes *Invalid* (Ineligible) and *Not Invalid* (either Eligible or Premature). We also note that decisions involving patent portfolios can have more than one outcome if some patents (or some claims) are ruled valid and others are not. The variable *Both* captures decisions where the court decided that some patent claims were Invalid and others were Not Invalid in the same decision.

b. Industry

Next, to capture the broad industry of the patent(s) at issue, we categorized decisions into three mutually exclusive subject matter categories: *Biotech/Life Science*, *Software/IT*, and *Other*. We based this categorization on the classifications provided in the Gibson Dunn dataset[47] and our manual review of the patents and asserting organizations involved in each case. Decisions in our Biotech/Life Science category include inventions in diagnostics and detection/measurement, methods of DNA analysis, amplification of genomic DNA, processes for freezing cells, treatment processes, drug administration or delivery, nutritional supplements, methods for

[46] Of the 48 instances of disagreement only 6 were completely improperly coded by third party sources. The remaining disagreements came from missing multiple outcomes in one decision or from whether the decision should be coded as eligible or premature.

[47] *See supra* note 36.

medical procedures, orthodontic devices and treatment plans, and DNA extraction and fractioning.

Decisions in our Software/IT category include innovations involving elements of digital processing systems, software for games, methods for distributing materials online, price optimization methods for online sales, algorithms for financial transactions, digital monitoring, methods for data storage and encoding, composite webpages, automatic lip-syncing for digital characters, and network resource access.

Finally, the eight decisions in our Other category include more mechanical innovations and methods including automotive parts, oil and gas riggings, aircraft engine washing systems, swings, and methods for pulling pipe underground.

c. Entity Status

To determine the types of patent asserters present in each decision, we relied on the classifications constructed and used in the Stanford NPE Litigation Dataset.[48] We matched all 860 decisions to the NPE Litigation Dataset using court names and case docket numbers (standardized between the two datasets) using the party names to ensure a correct match in cases where there were multiple matches for a decision. The NPE Litigation Dataset provides 13 patent asserter

[48] The Stanford NPE Litigation Dataset provides classifications for all patent asserters in every patent litigation suit reported in Lex Machina as well as the patents at issue. The data can be found at: https://npe.law.stanford.edu/. See Shawn P. Miller, et al., *Who's Suing Us? Decoding Patent Plaintiffs Since 2000 with the Stanford NPE Litigation Dataset* 21 STAN. TECH. L REV. 235 (2018) for a description of the dataset and classification criteria.

classifications and assigns a classification to every patent asserter listed in each Lex Machina patent suit. A summary of the NPE classifications is in Table 1.

TABLE 1. NPE LITIGATION DATASET CLASSIFICATIONS SUMMARY

No.	Category Name	Description
1	Acquired Patents	Companies with a purpose of generating revenue from patent licensing, but never made products.
2	University Heritage or Tie	Companies with ties to universities and/or exist to license university patents.
3	Failed Startup	Former startup companies with intentions to make products or offer services.
4	Corporate Heritage	Companies that formerly made products or offered services but shifted to patent licensing for revenue.
5	Individual-Inventor-Started Company	Companies that were founded by the inventors of held patents.
6	University/Government/NGO	Organizations that are institutions for higher learning, government entitles, or non-profit organizations.
7	Startup, Pre-product	Startup companies in the process of developing a product or offering a service.
8	Product Company	Companies that make or sell products or services.
9	Individual	Individuals that are inventors of their own patent.
10	Undetermined	No evidence is available to classify the entity.
11	Industry Consortium	Standards setting or other industry organization that holds intellectual property.
12	IP Subsidiary of Product Company	Holding Companies for product company patents.
13	Corporate-Inventor-Started Company	Company performs internal R&D and tends to license to manufacturers.

Because of the relatively small number of decisions in our dataset, our preferred specifications we combine some categories and create mutually exclusive groups. For example, decisions are categorized as having an *Individual* patent asserter if any asserters in the suit are defined as individuals or an individual

started company in the NPE Litigation Dataset (Categories 5 or 9). *Product Company* decisions are those with any asserter that is defined as a product company or IP subsidiary in the NPE Dataset (Categories 8 or 12) but not classified as Individual. *University* decisions are those with any asserter defined as a university/government entity/NGO or having a university heritage in the NPE database (Categories 2 or 6) but not in Individual or Product Company. *PAE Only* decisions are those with any asserter defined as acquiring patents in the NPE Database (Category 1), but not in Individual, University, or Product Company. *Other Asserter* decisions are those with asserters that are not in any of the other categories and includes startups, failed startups, industry consortiums, corporate started companies, and corporate heritage companies (Categories 3, 4, 7, 11, and 13).[49] We define *NPE* to be the broader set that includes Individuals, Universities, PAE Only, and Other Asserter.

d. Venue

For each decision, we track whether it was issued by a district court or the Federal Circuit. For some analyses we report results for separate district courts rather than aggregating them. Because Federal Circuit cases are appeals from a

[49] Because some cases have asserters in different NPE Dataset categories, and we bucket asserter types mutually exclusively, it is possible to create an alternative classification definition that groups *Product Companies* first (categories 8 and 12), then to define *Individuals* as categories 5 and 9, but not in Product Companies. The remaining categories then remain the same. Our results are robust to this alternative definition.

district court in our dataset, those observations are not entirely independent. To account for this, our regression results cluster results by case.

e. Other Variables

To control for other case characteristics that could be associated with the patent eligibility outcomes, we also included a number of variables on the case and previous asserter litigation behavior. Three main variables used in our models include the *Top 3% of Asserters*, the *Top 3% of Asserters in 101 Cases*, and if the *Case Involves 5+ Patents*. The *Top 3% of Asserters* is a measure of how often a particular plaintiff files patent lawsuits in general. It is constructed by first calculating the number of cases in the NPE Litigation Dataset by asserter and finding the top 3% of asserters in that set.[50] If any asserter in a decision is in the top 3%, then we code that decision as 1 and 0 otherwise. The *Top 3% of Asserters in 101 Cases* is constructed the same way as the *Top 3% of Asserters*, except we use our 101 dataset rather than the full NPE Litigation Dataset.[51] This is a measure of how often a particular asserter faces 101 decisions. *Case Involves 5+ Patents* is an indicator of cases with large portfolios that might be more likely to have multiple outcomes in a decision. A full list of the variables and their descriptions are provided in Table 2.

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[50] We use the top 3% since that is where a natural break occurs in the data. Using the top 1% results in too few observations from which to make inferences and the top 5% includes more asserters that have far fewer cases than the truly litigious.

[51] *Id.*

TABLE 2. VARIABLE NAMES AND DESCRIPTIONS

Variable Name	Description	Source
Ineligible / Invalid	= 1 if the court ruled against the patent asserter on eligible subject matter or Both; 0 otherwise	Author Collected Patent Eligibility Decisions
Eligible	= 1 if the court ruled for the patent asserter on eligible subject matter; 0 otherwise	Author Collected Patent Eligibility Decisions
Premature	= 1 if the court deemed the eligible subject matter validity challenge too early in the proceedings; 0 otherwise	Author Collected Patent Eligibility Decisions
Not Invalid	= 1 if a decision has either Eligible or Premature outcomes or Both; 0 otherwise	Author Collected Patent Eligibility Decisions
Both	= 1 if a decision contains both Invalid and Not Invalid outcomes; 0 otherwise	Author Collected Patent Eligibility Decisions
Not Invalid to Invalid	In cases where there are multiple decisions, = 1 if an earlier decision had a Not Invalid outcome and the later decision had an Invalid outcome; = 0 otherwise; = missing if only one decision	Author Collected Patent Eligibility Decisions
CAFC Decision	= 1 if the decision is from the Federal Circuit; 0 otherwise	Author Collected Patent Eligibility Decisions
CAFC Affirm	= 1 if the Federal Circuit decision affirms the lower court; 0 otherwise; missing if not CAFC	Author Collected Patent Eligibility Decisions
Rule 36 Decision	= 1 if the Federal Circuit decision is Rule 36; 0 otherwise; missing if not CAFC	Author Collected Patent Eligibility Decisions
Quarter	Quarter-Year decision was issued (format yyyyq#, e.g., 2016q1)	Author Collected Patent Eligibility Decisions
Biotech/Life Science	= 1 if the case associated with the decision is primarily about Biotech or Life Science inventions; 0 otherwise	Author Collected Patent Eligibility Decisions; Gibson Dunn
Software/IT	= 1 if the case associated with the decision is primarily about Software or IT inventions; 0 otherwise	Author Collected Patent Eligibility Decisions; Gibson Dunn
Other	= 1 if the case associated with the decision is primarily about inventions other than Biotech/Life Science or Software/IT; 0 otherwise	Author Collected Patent Eligibility Decisions; Gibson Dunn
Acquired Patents (1)	= 1 if the patent asserter(s) is in Category 1 "Acquired Patents" in the NPE Litigation Database; 0 otherwise	Stanford NPE Litigation Database

Variable Name	Description	Source
Univ. Heritage (2)	= 1 if the patent asserter(s) is in Category 2 "University Heritage or Tie" in the NPE Litigation Database; 0 otherwise	Stanford NPE Litigation Database
Failed Startup (3)	= 1 if the patent asserter(s) is in Category 3 "Failed Startup" in the NPE Litigation Database; 0 otherwise	Stanford NPE Litigation Database
Corp. Heritage (4)	= 1 if the patent asserter(s) is in Category 4 "Corporate Heritage" in the NPE Litigation Database; 0 otherwise	Stanford NPE Litigation Database
Indiv. Started Co. (5)	= 1 if the patent asserter(s) is in Category 5 "Individual-Inventor-Started Company" in the NPE Litigation Database; 0 otherwise	Stanford NPE Litigation Database
Univ./Gov./NGO (6)	= 1 if the patent asserter(s) is in Category 6 "University/Government/NGO" in the NPE Litigation Database; 0 otherwise	Stanford NPE Litigation Database
Startup (7)	= 1 if the patent asserter(s) is in Category 7 "Startup, pre-product" in the NPE Litigation Database; 0 otherwise	Stanford NPE Litigation Database
Product Co. (8)	= 1 if the patent asserter(s) is in Category 8 "Product Company" in the NPE Litigation Database; 0 otherwise	Stanford NPE Litigation Database
Individual (9)	= 1 if the patent asserter(s) is in Category 9 "Individual" in the NPE Litigation Database; 0 otherwise	Stanford NPE Litigation Database
Industry Consortium (11)	= 1 if the patent asserter(s) is in Category 11 "Industry Consortium" in the NPE Litigation Database; 0 otherwise	Stanford NPE Litigation Database
IP Subsidiary (12)	= 1 if the patent asserter(s) is in Category 12 "IP Subsidiary of Product Company" in the NPE Litigation Database; 0 otherwise	Stanford NPE Litigation Database
Corp. Started Co. (13)	= 1 if the patent asserter(s) is in Category 13 "Corporate-Inventor-Started Company" in the NPE Litigation Database; 0 otherwise	Stanford NPE Litigation Database
NPE, No Product Cos	= 1 if any patent asserter in the decision is NOT in NPE categories 8 or 12; 0 otherwise	Stanford NPE Litigation Database
NPE, No Product Cos or Indiv	= 1 if any patent asserter in the decision is not an Individual or Product Company; 0 otherwise	Stanford NPE Litigation Database
PAE Only	= 1 if any patent asserter in the decision is in NPE category 1, but not an Individual, Product Company, or University; 0 otherwise	Stanford NPE Litigation Database
Other Asserter	= 1 if any patent asserter in the decision is not an Individual, Product Company, University, or in Category 1; 0 otherwise	Stanford NPE Litigation Database
Individual	= 1 if any patent asserter in the decision is in NPE categories 5 or 9; 0 otherwise	Stanford NPE Litigation Database

Variable Name	Description	Source
University	= 1 if any patent asserter in the decision is in NPE Category 2 or 6, but not an Individual or Product Company; 0 otherwise	Stanford NPE Litigation Database
Product Company	= 1 if any patent asserter in the decision is in NPE Category 8 or 12, but not an Individual; 0 otherwise	Stanford NPE Litigation Database
Top 3% of Asserters	= 1 if any patent asserter in the decision is in the top 3% of patent asserters as measured by the number of cases in the NPE Litigation Database; 0 otherwise	Stanford NPE Litigation Database
Top 3% of Asserters in 101 Cases	= 1 if any patent asserter in the decision is in the top 3% of patent asserters as measured by the number of 101 cases in the collected patent eligibility decisions	Author Collected Patent Eligibility Decisions
Case Involves 5+ Patents	= 1 if the case associated with the decision involves five or more patents; 0 otherwise	Stanford NPE Litigation Database

III. What We Found

A. Basic Descriptive Statistics

While we analyzed 860 total unique decisions, several of those were decisions in the same cases on the same patent. To avoid over-weighting the importance of cases that had more than one patent eligibility decision on the same patent, for most of our analysis we focused on the last decision in a particular case in the district court and, separately, the last decision in the case in the Federal Circuit.[52] This includes only counting one decision for situations where the same patent was

[52] While that does mean that for roughly 25% of the cases in our study there are two decisions from the same case – one from the district court and one from the Federal Circuit – excluding the district court decision altogether in those cases would have given us a skewed picture of how courts were deciding 101 cases. Nonetheless, there is reason to worry that those two decisions are not independent of each other despite the fact that patentable subject matter is a legal issue reviewed without deference on appeal. *In re* Ferguson, 558 F.3d 1359, 1363 (Fed. Cir. 2009) ("Whether a claim is drawn to patent-eligible subject matter under § 101 is an issue of law that we review de novo."); OIP Techs., Inc. v. Amazon.com, Inc., 788 F.3d 1359, 1362 (Fed. Cir. 2015); *contra* Berkheimer v. HP Inc., 881 F.3d 1360, 1368 (Fed. Cir. 2018). We adjust for the non-independence between these decisions in our regression analysis below.

brought against multiple defendants under different cases, which avoids double counting what is effectively the same decision and outcome. These modifications gave us 808 unique case decisions that form the core of our analysis. We chose to initially report the district court and Federal Circuit decisions together to show the general trends of patent holders facing 101 challenges and to be comparable to other public data on 101 decisions.[53] Later sections and our regressions break the district court and Federal Circuit results out separately.

Table 3 provides the summary statistics of all variables described above for the 808 unique decisions.

TABLE 3. SUMMARY STATISTICS FOR LAST DECISIONS IN DISTRICT COURT AND THE FEDERAL CIRCUIT

Variable Name	N	Mean	Std. Dev.	Min	Max
Ineligible / Invalid	808	0.631	0.483	0	1
Eligible	808	0.269	0.443	0	1
Premature	808	0.162	0.369	0	1
Not Invalid	808	0.423	0.494	0	1
Both	808	0.054	0.227	0	1
Not Invalid to Invalid	35	0.371	0.490	0	1
CAFC Decision	808	0.200	0.401	0	1
CAFC Affirm	162	0.914	0.282	0	1

[53] Although we do not have their underlying decisions for additional validation, our results are similar to those released by Robert R. Sachs in IP Watchdog, "Alice: Benevolent Despot or Tyrant? Analyzing Five Years of Case Law Since Alice v. CLS Bank": Part I on August 29, 2019 (https://www.ipwatchdog.com/2019/08/29/alice-benevolent-despot-or-tyrant-analyzing-five-years-of-case-law-since-alice-v-cls-bank-part-i/id=112722/) and Part II on September 3, 2019 (https://www.ipwatchdog.com/2019/09/03/alice-benevolent-despot-or-tyrant-analyzing-five-years-of-case-law-since-alice-v-cls-bank-part-ii/id=112769/). The blog posts update Greg Hopewell, Christopher King, and Robert R. Sachs, *Benevolent Despot or Tyrant? Alice v CLS Bank Five Years on*, IAM (May 23, 2019), (https://www.iam-media.com/benevolent-despot-or-tyrant-alice-v-cls-bank-five-years).

Variable Name	N	Mean	Std. Dev.	Min	Max
Rule 36 Decision	162	0.525	0.501	0	1
Quarter	808	2017q1	5.433	2014q3	2019q2
Biotech/Life Science	808	0.094	0.292	0	1
Software/IT	808	0.896	0.305	0	1
Other	808	0.010	0.099	0	1
Acquired Patents (1)	808	0.282	0.450	0	1
Univ. Heritage (2)	808	0.007	0.086	0	1
Failed Startup (3)	808	0.014	0.116	0	1
Corp. Heritage (4)	808	0.026	0.159	0	1
Indiv. Started Co. (5)	808	0.188	0.391	0	1
Univ./Gov./NGO (6)	808	0.019	0.135	0	1
Startup (7)	808	0.002	0.050	0	1
Product Co. (8)	808	0.467	0.499	0	1
Individual (9)	808	0.047	0.212	0	1
Industry Consortium (11)	808	0.005	0.070	0	1
IP Subsidiary (12)	808	0.025	0.155	0	1
Corp. Started Co. (13)	808	0.002	0.050	0	1
NPE, No Product Cos	808	0.526	0.500	0	1
NPE, no Product Cos or Indiv	808	0.314	0.465	0	1
PAE Only	808	0.277	0.448	0	1
Other Asserter	808	0.026	0.159	0	1
Individual	808	0.233	0.423	0	1
University	808	0.011	0.105	0	1
Product Company	808	0.453	0.498	0	1
Top 3% of Asserters	808	0.312	0.464	0	1
Top 3% of Asserters in 101 Cases	808	0.087	0.281	0	1
Case Involves 5+ Patents	805	0.277	0.448	0	1

Of the 808 patentable subject matter decisions, 63.1% found a patent invalid on patentable subject matter grounds and 42.3% found a patent not invalid on patentable subject matter grounds.[54] But some of the decisions holding the claim not invalid were only preliminary decisions, not definitively rejecting the argument

[54] We will sometimes use the term "valid" in this paper, but the reader should understand that the rulings we evaluate only determine whether the patent is invalid for lack of patentable subject matter. Those patents might or might not be invalid on other grounds. The percentages don't add to 100% because 5.4% of the cases involved split decisions, finding some patent claims invalid and others not invalid.

but holding that it was premature. Overall, 26.9% were held to definitively constitute patentable subject matter and another 16.2% simply held that the challenge to validity was premature. In 35 cases, the court originally found the 101 challenge to be premature, but came back later with a definitive ruling. When they did, 37.1% of the second-bite cases held the claims unpatentable at the second hearing.[55] The total breakdown of last decision outcomes is depicted below in both its simpler and more complex forms, Figures 1A and 1B.

FIGURES 1A AND 1B. PATENT ELIGIBILITY OUTCOMES BY DECISION

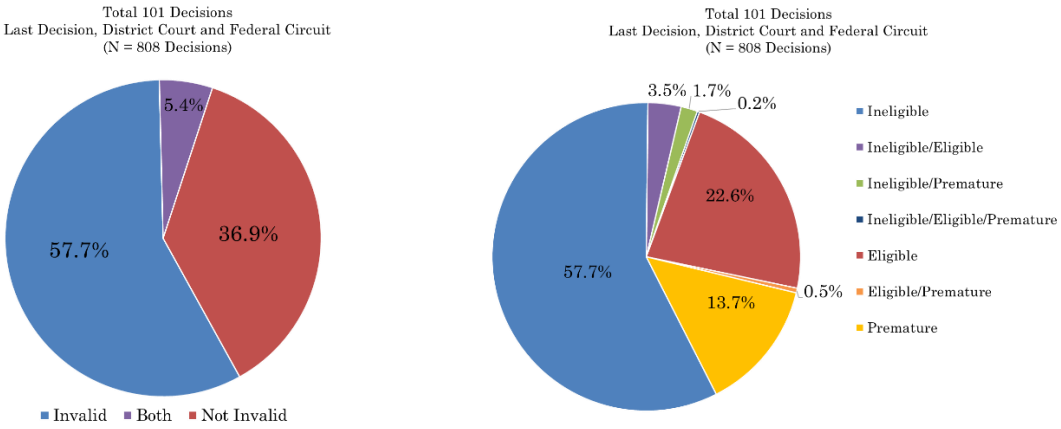


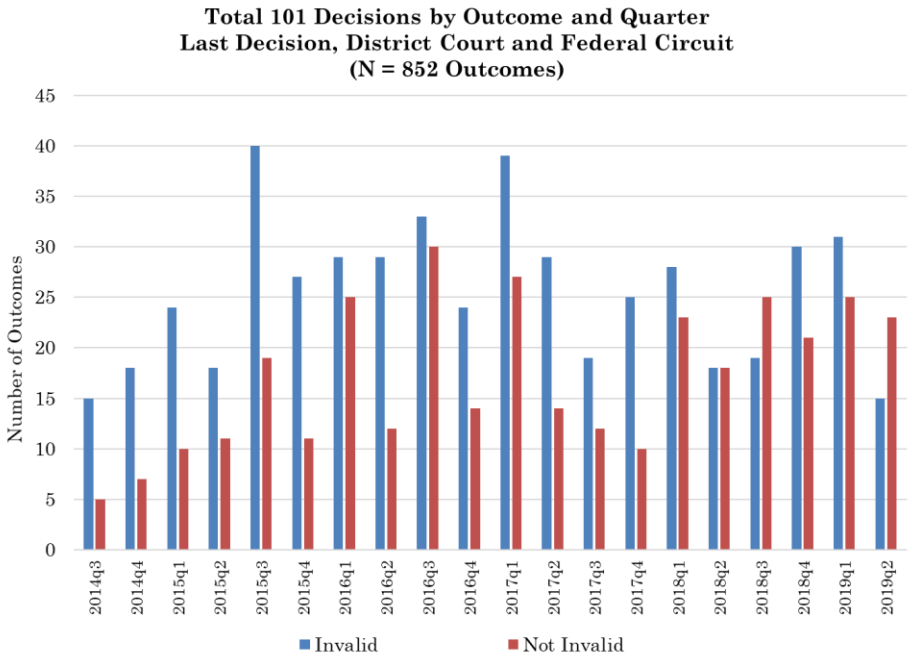
Figure 1A shows the percentage of the 808 decisions that only had Invalid outcomes (57.7%), only Not Invalid outcomes (36.9%), and both Invalid and Not Invalid outcomes in the same decision (5.4%). Figure 1B shows the same decisions, but breaks Not Invalid outcomes into separate Eligible and Premature categories. By design, the Ineligible outcome is the same as Invalid in Figure 1A (57.7%); decisions with only Eligible outcomes make up 22.6% of the total; and those with only

55 For these 35 cases, we only included the final ruling on the merits of the 101 challenge.

Premature outcomes make up 13.7% of the total. The remaining decisions had different outcomes for different claims or patents. For example, in a decision labeled Ineligible/Eligible/Premature, the judge ruled some of the patents ineligible, others eligible, and reserved judgement on the rest.

We also studied the change in *Alice* outcomes over time.[56] There is a decided trend in the decisions toward more patent-friendly outcomes. While immediate post-*Alice* decisions overwhelmingly invalidated the patents, the results by 2018 and 2019 were much closer to 50-50 (Figure 2).

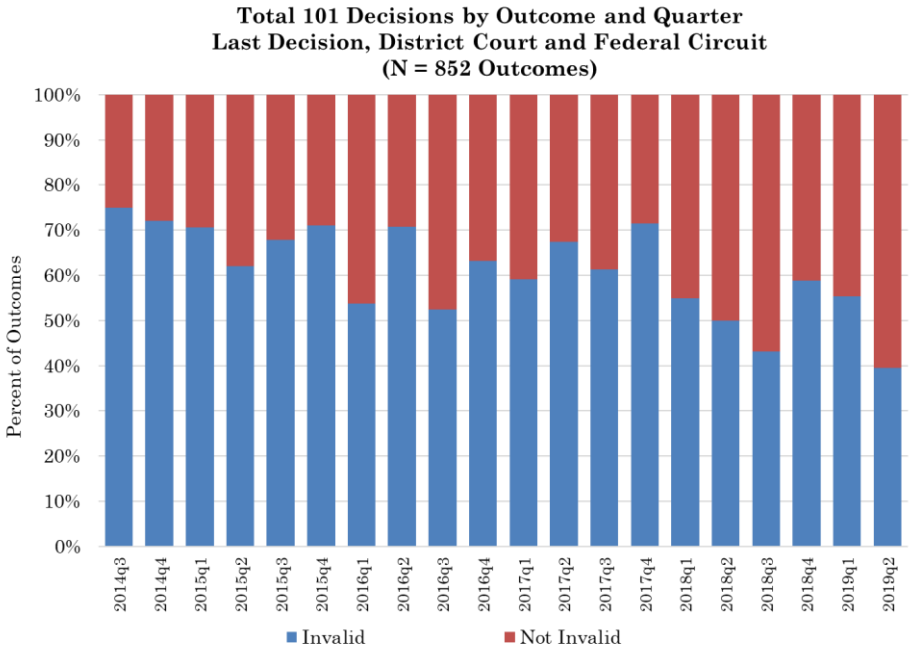
FIGURE 2. PATENT ELIGIBILITY OUTCOMES OVER TIME



[56] The 808 decisions resulted in 852 Invalid or Not Invalid outcomes because some judges ruled more than one way on different patents in the same decision.

Indeed, by the last quarter of our study 60% of the rulings upheld the patent (Figure 3).

FIGURE 3. PERCENTAGE OF PATENT ELIGIBILITY OUTCOMES OVER TIME



To some extent this reflects timing and procedure. A number of early post-*Alice* cases arguably reflected low-hanging fruit, so it makes sense that cases from the earlier part of our study were more likely to invalidate patents. As the low-hanging fruit is cleared, as more defendants discover *Alice* and start arguing patentable subject matter, and as weaker cases possibly settle sooner, it makes sense that the invalidation rate will decline.[57] The Federal Circuit's February 2018 decision in

[57] Paul R. Gugliuzza and Mark A. Lemley, *Can a Court Change the Law By Saying Nothing?* 71 VANDERBILT L. REV. 765, 768 (2018) ("Once the Federal Circuit begins reviewing more decisions upholding validity, the court's high rate of finding invalidity could decrease.").

Berkheimer[58] also may have contributed to the district courts' recent reluctance to invalidate patents too early in the proceedings. In *Berkheimer*, the Federal Circuit vacated and remanded the district court's decision to grant summary judgement on 101 invalidity with respect to claims , concluding that the section 101 determination involved disputed issues of fact despite its status (until then, at least) as a pure question of law.[59] Since then, the share of district court 101 decisions with Premature outcomes has risen on average from 21% of first district court decisions before *Berkheimer* to 28% after. We use the first decision here to mitigate the fact that older cases have more time for the court to issue a dispositive ruling after a premature ruling, where newer cases would not have gotten as far in the proceedings. Figure 4 illustrates the higher and slightly faster rate of premature outcomes before and after *Berkheimer* (Figure 4).[60]

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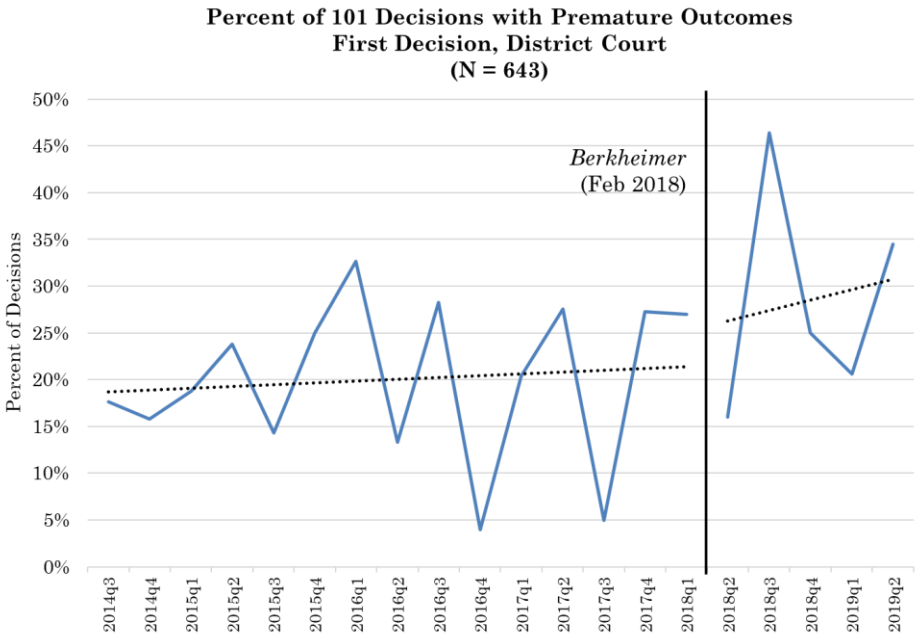
58 Berkheimer v HP Inc., 881 F.3d 1360, 1370 (2018) ("At this stage of the case, however, there is at least a genuine issue of material fact … making summary judgment inappropriate with respect to these claims.")

59 *Id*.

60 We note that with very few data points after *Berkheimer*, the differences are not statistically significant and the rates of change could be more similar after more time has passed.

FIGURE 4. CHANGE IN THE SHARE OF PREMATURE OUTCOMES IN DISTRICT COURT



Therefore, there are at least two potentially different mechanisms that could be contributing to the decline in invalidity outcomes. The first is changes in the legal rule of decision and the second is litigant's selection into a suit given the new rules. Unfortunately, our data will not allow us to separate the effects of the two mechanisms.

B. Industry Differences

Much of the rancor around patentable subject matter is a function of industry differences. It is well-known that different industries value and experience the patent system very differently.[61] That difference has played out in the wake of *Alice*

61 Dan L. Burk & Mark A. Lemley, THE PATENT CRISIS AND HOW THE COURTS CAN SOLVE IT 4-5 (2009). James Bessen and Michael J. Meurer, PATENT FAILURE: HOW JUDGES, BUREAUCRATS, AND LAWYERS PUT INNOVATORS AT RISK __ (2009). Dan L. Burk & Mark A.

as well. Many in the software and information technology (IT) industries, which faced a major problem with frivolous litigation from non-practicing entities,[62] reacted favorably to the availability of a quick and cheap means of weeding out weak patents.[63] By contrast, companies in the biotech and life sciences industry, which relies much more heavily on the patent system, worry that *Alice* will make large swaths of their industry unpatentable.[64] For purposes of our analysis we broadly categorize decisions into Biotech/Life Science, Software/IT, and Other as described above.[65]

In fact, we find that in court *Alice* has overwhelmingly been a doctrine about IT, not life sciences. 90% of post-*Alice* decisions are in the Software/IT industry; only 9% are Biotech/Life Science decisions. And almost all *Alice* cases come from those industries; only 1% of decisions involve other industries as shown in Figure 5.

Lemley, *Is Patent Law Technology-Specific?*, 17 BERKELEY TECH. L.J. 1155, 1160 (2002). Dan L. Burk & Mark A. Lemley, *Policy Levers in Patent Law*. 89 VIRGINIA L. REV. 1575, 1595 (2003) ("…at virtually every stage of both the innovation and patent processes, different industries have different needs and experience the patent system differently.").

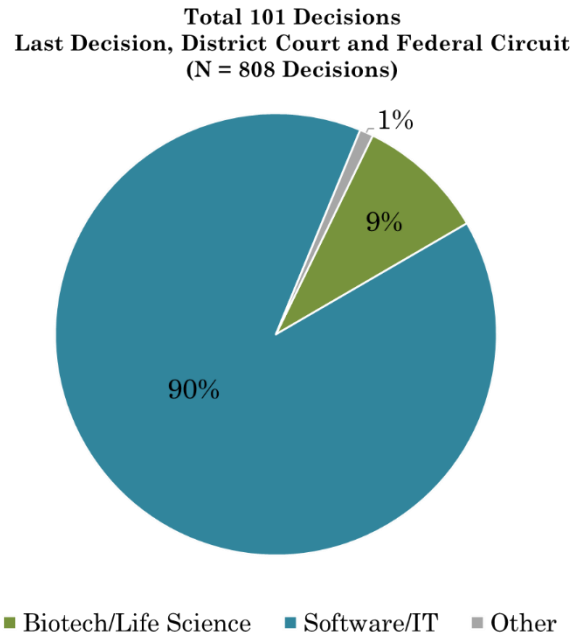
62 John R. Allison, Mark A. Lemley, and David L. Schwartz, *How Often Do Non-Practicing Entities Win Patent Suits?*, 32 BERKELEY TECH. L. J. 237, 263-264 (2017). John R. Allison, Mark A. Lemley & David L. Schwartz, *Our Divided Patent System*, 82 U. CHI. L. REV. 1073 (2015). Colleen V. Chien, *Of Trolls, Davids, Goliaths, and Kings: Narratives and Evidence in the Litigation of High-Tech Patents*, 87 N.C. L. REV. 1571 (2009). Christopher A. Cotropia, Jay P. Kesan, and David L. Schwartz, *Unpacking Patent Assertion Entities (PAEs)*, 99 MINNESOTA L. REV. 649, 679-682 (2014).

63 U.S. PATENT &TRADEMARK OFF., PATENT ELIGIBLE SUBJECT MATTER: REPORT ON VIEWS AND RECOMMENDATIONS FROM THE PUBLIC 37 (2017).

64 U.S. PATENT &TRADEMARK OFF., PATENT ELIGIBLE SUBJECT MATTER: REPORT ON VIEWS AND RECOMMENDATIONS FROM THE PUBLIC 35-36 (2017).

65 See *supra* Section II.B.b.

FIGURE 5. PATENT ELIGIBILITY DECISIONS BY INDUSTRY



Further, the few biotech/life science patents seem to fare better in court than software/IT patents do.[66] 56.6% (43) of post-*Alice* biotech/life sciences court decisions uphold a patent, compared with 40.3% (292) of software/IT court decisions. The higher percentage of Not Invalid biotech/life science decisions are primarily from actual findings of validity, not conclusions that the patentable subject matter issue was premature (Tables 4A and 4B).[67] That is not to deny the concern life

[66] The difference in the upheld rate is statistically significant at the 95% level. Using a simple test for the difference in proportions by software/IT decisions and biotech/life science decisions (prtest in STATA) the difference has a p-value of 0.0063. Using a test for the difference in proportions that also controls for the fact that district court and Federal Circuit cases are likely to have the same outcome (prtest clustering by case and assuming the intraclass correlation is rho = 0.8333, as calculated from a one-way random effects model for Not Invalid outcomes by case) the difference still has a p-value of 0.0276).

[67] For biotech/life science, 72% (31 of 43) of Not Invalid decisions are findings of eligibility rather than decisions that the issue is premature, while only 60% (180 or 298) of Not Invalid decisions are findings of eligibility for software/IT.

sciences companies have with the decisions that affect them, particularly at the Federal Circuit. As we have seen, some of those decisions have attracted considerable controversy. But we're talking about a small universe of cases – only 38 life sciences invalidity decisions, less than 5% of our total study.

TABLES 4A AND 4B. PATENT ELIGIBILITY OUTCOMES BY INDUSTRY[68]

	All	Software/IT	Biotech/ Life Science
Invalid Outcome in Decision	510	471	38
Not Invalid Outcome in Decision	342	292	43
Total Decisions	808	724	76
% Decisions w/ Invalid Outcomes	63.1%	65.1%	50.0%
% Decisions w/ Not Invalid Outcomes	42.3%	40.3%	56.6%
Percent of All Decisions		89.6%	9.4%

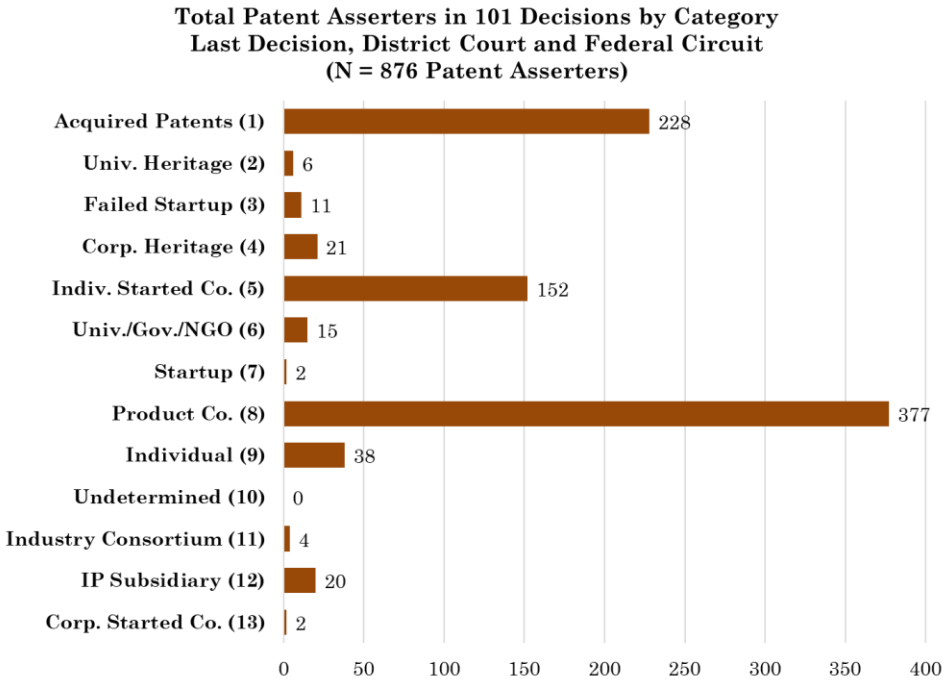
	All	Software/IT	Biotech/ Life Science
Ineligible Outcome in Decision	510	471	38
Eligible Outcome in Decision	217	180	31
Premature Outcome in Decision	131	118	12
Total Decisions	808	724	76
% Decisions w/ Ineligible Outcomes	63.1%	65.1%	50.0%
% Decisions w/ Eligible Outcomes	26.9%	24.9%	40.8%
% Decisions w/ Premature Outcomes	16.2%	16.3%	15.8%
Percent of All Decisions		89.6%	9.4%

[68] Total outcomes are greater than total decisions because some decisions have more than one outcome.

C. Entity Status – Does *Alice* Target Patent Trolls?

We also found that the nature of the patent plaintiff bears significantly on how its patents fare under *Alice*. Figure 6 shows that while a plurality of decisions in our study involved at least one practicing entity (377 in "Product Company" and 20 in "IP Subsidiary"), the majority involved some type of non-practicing entity (NPEs) or individual inventor.[69] The most common NPE patent owners in patent eligibility decisions were companies in the business of buying and asserting patents (patent assertion entities, or PAEs) (228 in "Acquired Patents"), followed by individual inventors and the companies they started (152 in "Individual-Started Company" and 38 in "Individual").

FIGURE 6. PATENT ASSERTER TYPES IN PATENT ELIGIBILITY DECISIONS



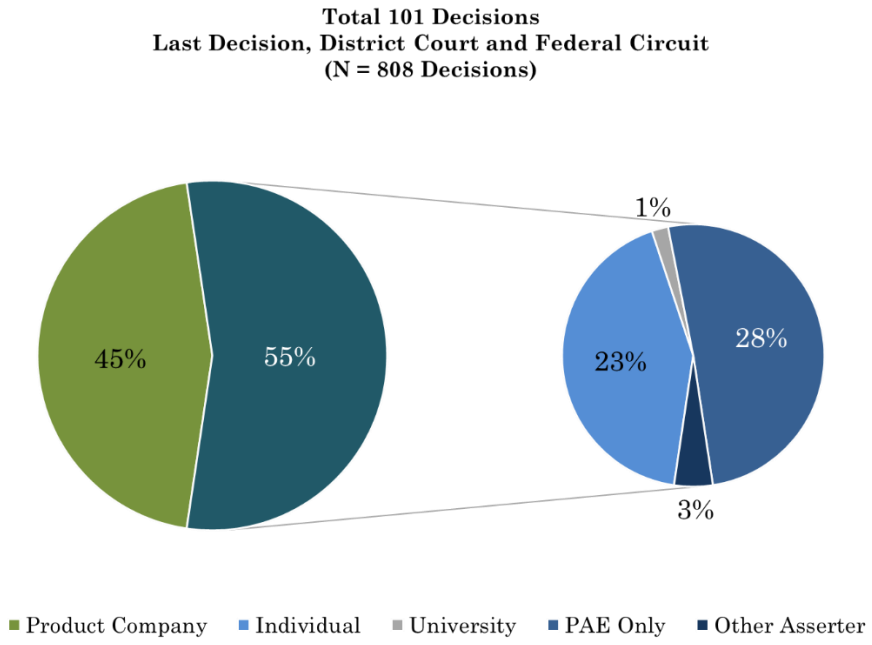
69 See *supra* Section II.B.c for a discussion of the NPE Litigation Dataset categories used in this paper.

Since many of the asserter types have only limited representation in our dataset, we collapse the types into mutually exclusive categories and assign each decision to only one category: Product Company, Individual, University, PAE Only, and Other Asserter (the latter four making up the NPE decisions).[70] Together, those categories account for all the patentable subject matter cases. As Figure 7 shows, 45% of patent eligibility decisions are from cases brought primarily by Product Companies and the majority (55%) are brought by an NPE asserter. Of the NPE asserters, 51% are PAEs and 43% are Individuals. Notably, these shares roughly track the overall shares of patent suits around this time period,[71] so it doesn't appear that patentable subject matter comes up significantly more frequently in NPE suits than in practicing entity suits.

[70] Our mutually exclusive categories were created by combining like asserter types and assigning each decision to only one category. Decisions were assigned to "Individual" if at least one asserter was in NPE Litigation Database types 5 or 9. Decisions were assigned to "Product Company" if at least one asserter was in NPE Litigation Database types 8 or 12 and not in "Individual". Decisions were assigned to "University" if at least one asserter was in NPE Litigation Database types 2 or 6 and not in "Individual" or "Product Category". Decisions were assigned to "PAE Only" if at least one asserter was in NPE Litigation Database type 1 and not in "Individual," "Product Category," or "University". All remaining decisions were assigned to "Other Asserters," primarily NPE Litigation Database types 3, 4, 7, 11, and 13 (there are no asserters in type 10). See *supra* Section II.B.c

[71] Shawn P. Miller, et al., *Who's Suing Us? Decoding Patent Plaintiffs Since 2000 with the Stanford NPE Litigation Dataset,* 21 STAN. TECH. L REV. 235, 260 (2018). John R. Allison, Mark A. Lemley, and David L. Schwartz, *How Often Do Non-Practicing Entities Win Patent Suits?*, 32 BERKELEY TECH. L.J. 237, 257 (2017). Both studies focus on suits in 2015 and before, but the trends suggest that the number of NPE suits will continue to dominate the number of product company suits.

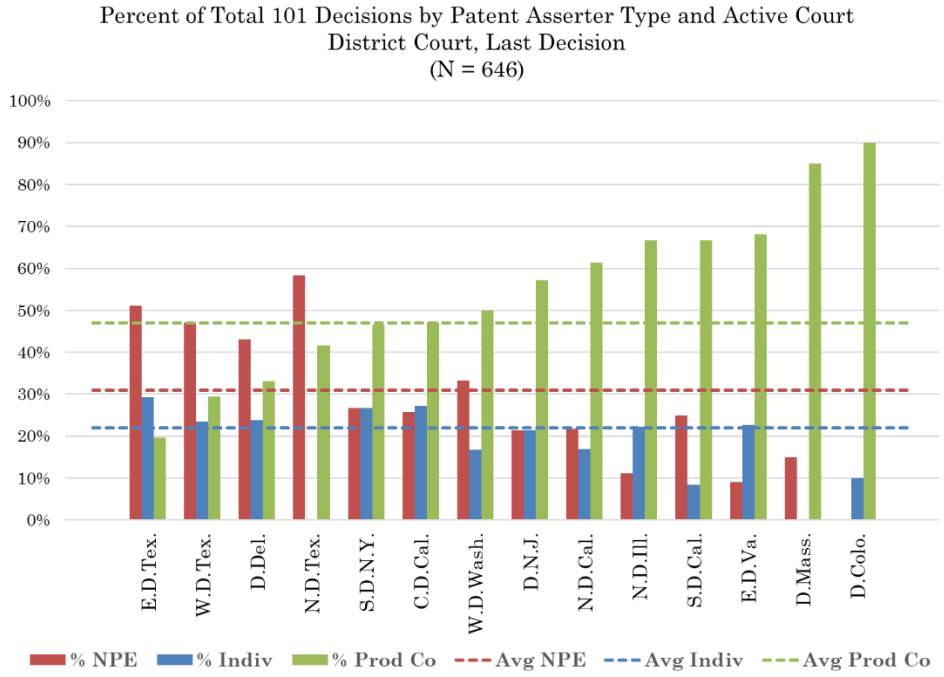
FIGURE 7. PATENT ELIGIBILITY DECISIONS BY PATENT ASSERTER TYPE



However, Individuals and Other NPEs (i.e., University/PAE Only/Other Asserter) tend to bring cases disproportionately in certain districts. NPEs and Individuals appear to make up a larger share of 101 decisions in districts such as the Eastern District of Texas and Delaware while Product Companies appear more often in districts like New Jersey, the Northern District of California, and Massachusetts. Figure 8 shows the percent of decisions by patent asserter type in each district with 10 or more decisions. It also includes the overall average for each asserter type.[72]

[72] Figure 8 only includes the last decision from the district court to focus on where the case was when the decision issued. It does not include decisions from the Federal Circuit. However, we do discuss which districts send appeals to the Federal Circuit in Section III.D.

FIGURE 8. PATENT ASSERTERS BY TYPE AND DISTRICT COURT



In one of our most striking findings, entity status matters to patentable subject matter outcomes, especially when we break out Individuals from other NPEs. Overall, patents were invalidated in 57.4% of product company decisions, 63.8% of NPE[73] decisions, and a striking 73.4% of individual inventor and inventor-started company decisions as shown in Tables 5A and 5B.[74] The story gets even

[73] We define NPE decisions here to be any category other than Product Company or Individual (i.e., University, Other Asserter, and PAE Only). As shown in Figure 7, PAEs make up the majority of non-individual NPEs.

[74] The difference in the overall invalidity rate between NPEs and Individuals is statistically significant at the 90% level. Using a simple test for the difference in proportions by NPE and Individual decisions (prtest in STATA) the difference has a p-value of 0.0322. Using a test for the difference in proportions that also controls for the fact that district court and Federal Circuit cases are likely to have the same outcome (prtest clustering by case and assuming the intraclass correlation is rho = 0.8333, as calculated from a one-way random effects model for Invalid outcomes by case) the difference has a p-value of 0.0769). The difference for the invalidity rate between Individuals and Product Companies is significant at the 99% level (unadjusted p-value = 0.0002 and adjusted p-value = 0.0020). There is no significant

worse for individual inventors when you distinguish true holdings of patentable subject matter from decisions that reject a challenge as premature. Only 13.8% of individual inventor decisions found the patents eligible outright, less than half the rate for both other NPEs and practicing entities.[75]

As noted above, the vast majority of all the decisions in our study are in the Software/IT industry. That is even more true when we consider NPEs. Relatively few life sciences decisions involve NPEs or individual inventors, and it's hard to draw meaningful conclusion about NPEs in the biotech/life science industry.

difference for the invalidity rate between NPEs and Product companies, however (unadjusted p-value = 0.1095 and adjusted p-value = 0.1854).

[75] The difference in the overall Eligibility rate between NPEs and Individuals is statistically significant at the 99% level. Using a simple test for the difference in proportions by NPE and Individual decisions (prtest in STATA) the difference has a p-value of 0.0004. Using a test for the difference in proportions that also controls for the fact that district court and Federal Circuit cases are likely to have the same outcome (prtest clustering by case and assuming the intraclass correlation is rho = 0.9375, as calculated from a one-way random effects model for Eligible outcomes by case) the difference has a p-value of 0.0041). The difference for the eligibility rate between Individuals and Product Companies is significant at the 99.9% level (unadjusted p-value = 0.0000 and adjusted p-value = 0.0001). There is no significant difference for the eligibility rate between NPEs and Product companies, however (unadjusted p-value = 0.1998 and adjusted p-value = 0.2980).

TABLES 5A AND 5B. PATENT ELIGIBILITY OUTCOMES
BY ASSERTER TYPE AND INDUSTRY[76]

	All Decisions			IT Decisions			Bio Decisions		
	NPE	**Indiv**	**Prod Co**	**NPE**	**Indiv**	**Prod Co**	**NPE**	**Indiv**	**Prod Co**
Invalid Outcome in Decision	162	138	210	159	136	176	3	2	33
Not Invalid Outcome in Decision	110	53	179	106	49	137	3	4	36
Total Decisions	254	188	366	247	182	295	6	6	64
% Decisions w/ Invalid Outcomes	63.8%	73.4%	57.4%	64.4%	74.7%	59.7%	50.0%	33.3%	51.6%
% Decisions w/ Not Invalid Outcomes	43.3%	28.2%	48.9%	42.9%	26.9%	46.4%	50.0%	66.7%	56.3%

	All Decisions			IT Decisions			Bio Decisions		
	NPE	**Indiv**	**Prod Co**	**NPE**	**Indiv**	**Prod Co**	**NPE**	**Indiv**	**Prod Co**
Ineligible Outcome in Decision	162	138	210	159	136	176	3	2	33
Eligible Outcome in Decision	71	26	120	68	24	88	2	2	27
Premature Outcome in Decision	43	27	61	42	25	51	1	2	9
Total Decisions	254	188	366	247	182	295	6	6	64
% Decisions w/ Ineligible Outcomes	63.8%	73.4%	57.4%	64.4%	74.7%	59.7%	50.0%	33.3%	51.6%
% Decisions w/ Eligible Outcomes	28.0%	13.8%	32.8%	27.5%	13.2%	29.8%	33.3%	33.3%	42.2%
% Decisions w/ Premature Outcomes	16.9%	14.4%	16.7%	17.0%	13.7%	17.3%	16.7%	33.3%	14.1%

D. The Role of the Federal Circuit

One of our other striking results concerns the differences between district court and Federal Circuit decisions. As shown in Tables 6A and 6B, district judges invalidated a patent in 56.7% of their final decisions on patentable subject matter. The Federal Circuit, by contrast, invalidated a patent in 88.9% of its final

[76] Total outcomes are greater than total decisions because some decisions have more than one outcome.

decisions.[77] That is a remarkable difference. It's so great that we have to separately take into account outcomes in the Federal Circuit and the District Courts so that the high level of Federal Circuit invalidation doesn't obscure all the rest of our results.[78]

TABLES 6A AND 6B. PATENT ELIGIBILITY OUTCOMES BY COURT[79]

	All Decisions	
	District Courts	**Federal Circuit**
Invalid Outcome in Decision	366	144
Not Invalid Outcome in Decision	319	23
Total Decisions	646	162
% Decisions w/ Invalid Outcomes	56.7%	88.9%
% Decisions w/ Not Invalid Outcomes	49.4%	14.2%

	All Decisions	
	District Courts	**Federal Circuit**
Ineligible Outcome in Decision	366	144
Eligible Outcome in Decision	196	21
Premature Outcome in Decision	129	2
Total Decisions	646	162
% Decisions w/ Ineligible Outcomes	56.7%	88.9%
% Decisions w/ Eligible Outcomes	30.3%	13.0%
% Decisions w/ Premature Outcomes	20.0%	1.2%

It is also largely hidden. We find that more than half (52.5%) of the Federal Circuit patentable subject matter rulings were decided without opinion under Rule

[77] The difference in the overall invalidity rate between district courts and the Federal Circuit is statistically significant at the 99.9% level. Using a simple test for the difference in proportions by district courts and the Federal Circuit decisions (prtest in STATA) the difference has a p-value of 0.0000.

[78] We do this in the full regression models discussed in Section III.E.

[79] Total outcomes are greater than total decisions because some decisions have more than one outcome.

36. All those were affirmances of invalidation decisions. The result, as Gugliuzza and Lemley have noted, is that just reading court decisions gives a distorted picture of what the Federal Circuit is doing.[80] While then-Federal Circuit Judge Rader once infamously (and inaccurately) called the PTAB "death squads, killing property rights,"[81] in fact the Federal Circuit's "kill rate" is quite a bit higher than the PTAB's, at least on this issue.

Some of this large difference can likely be explained by the declining invalidation rate over time.[82] Despite the de novo standard of review, the Federal Circuit affirms most district court decisions, in patentable subject matter as elsewhere.,[83] *Berkheimer* might be changing that, however, as we show in Figure 9.[84]

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80 Gugliuzza & Lemley, *supra* note 32.

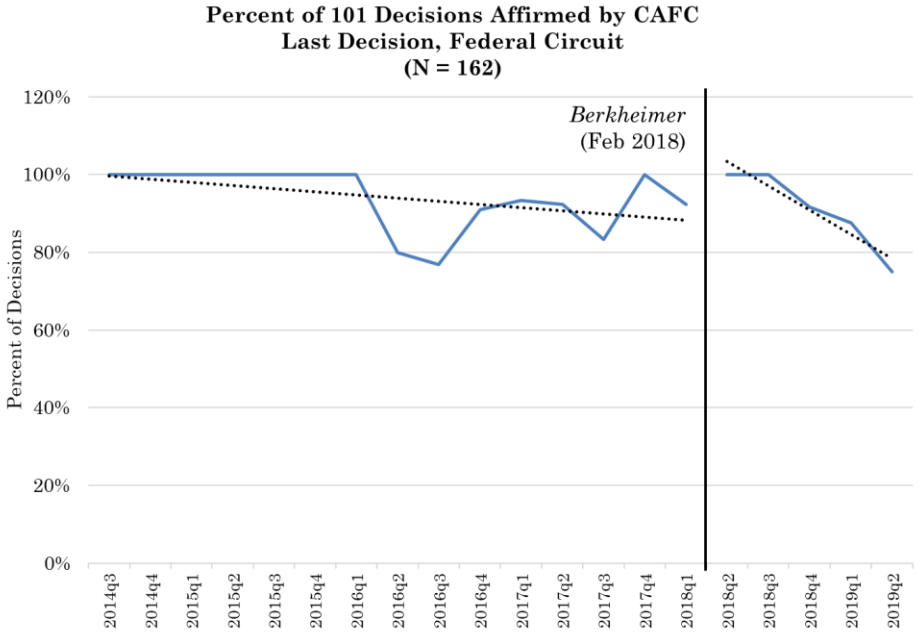
81 Tony Dutra, *Rader Regrets CLS Bank Impasse, Comments on Latest Patent Reform Bill*, BNA PAT. TRADEMARK & COPYRIGHT L. DAILY, Oct. 29, 2013.

82 *See supra* section III.A.

83 Chris Guthrie & Tracey E. George, *The Futility of Appeal: Disciplinary Insights into the "Affirmance Effect" on the United States Courts of Appeals*, 32 FLA. ST. U. L. REV. 357, 358 (2005) ("Affirmances are a defining feature of the courts of appeals: the courts of appeals *affirmed* 90% of the cases they decided…"). This high affirmation trend continues today in patent cases, see Dan Bagatell, Fed. Circ. Patent Decisions in 2018: An Empirical Review (January 3, 2019) (https://www.perkinscoie.com/images/content/2/1/v3/216639/Fed.-Circ.-Patent-Decisions-In-2018-An-Empirical-Review.pdf). The Federal Circuit affirmed 91% of the 162 decisions it issued in patent eligibility cases.

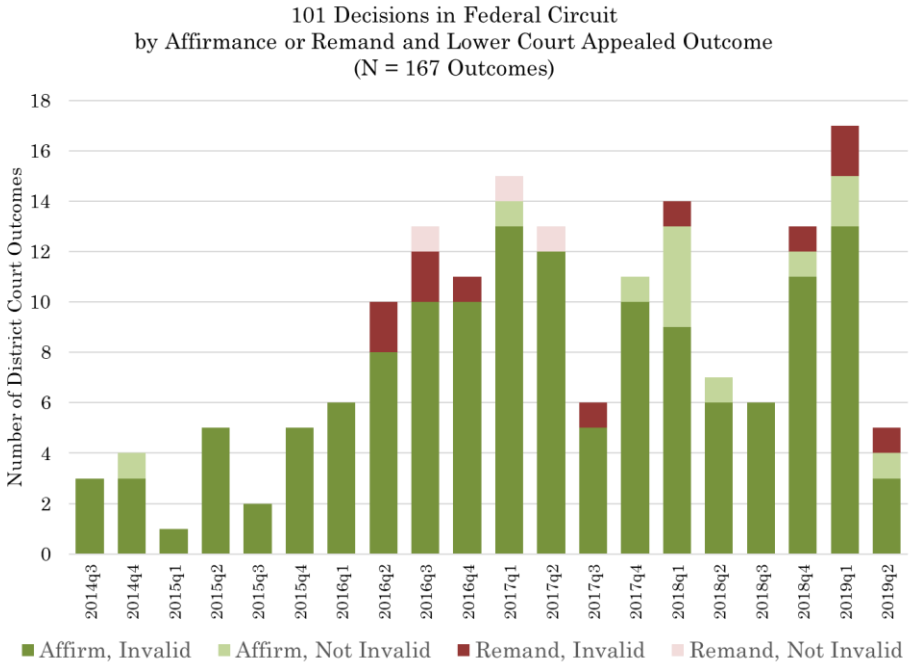
84 Caution should be used when interpreting the slopes of the affirmation rates before and after *Berkheimer* as there are only a few data points after the ruling from which to make inferences. Indeed, a Chow test, commonly used to compare the differences in slopes between two groups, will not allow us to reject the null hypothesis that the affirmation rate slopes before and after *Berkheimer* are the same (test statistic distributed as $F(2, 158) = 1.22$ with a p-value = 0.2966).

FIGURE 9. PERCENT OF 101 DECISIONS AFFIRMED BY FEDERAL CIRCUIT



Further, invalidations from the district courts head more quickly to the Federal Circuit, because they usually end the case at the district court. By contrast, rejecting a patentable subject matter challenge or deferring it means that the case continues in the district court. It may settle or be resolved on other grounds. So appeals from district court findings of validity are fewer and later than appeals from invalidations and the Federal Circuit is less likely to overturn or vacate those findings (Figure 10).

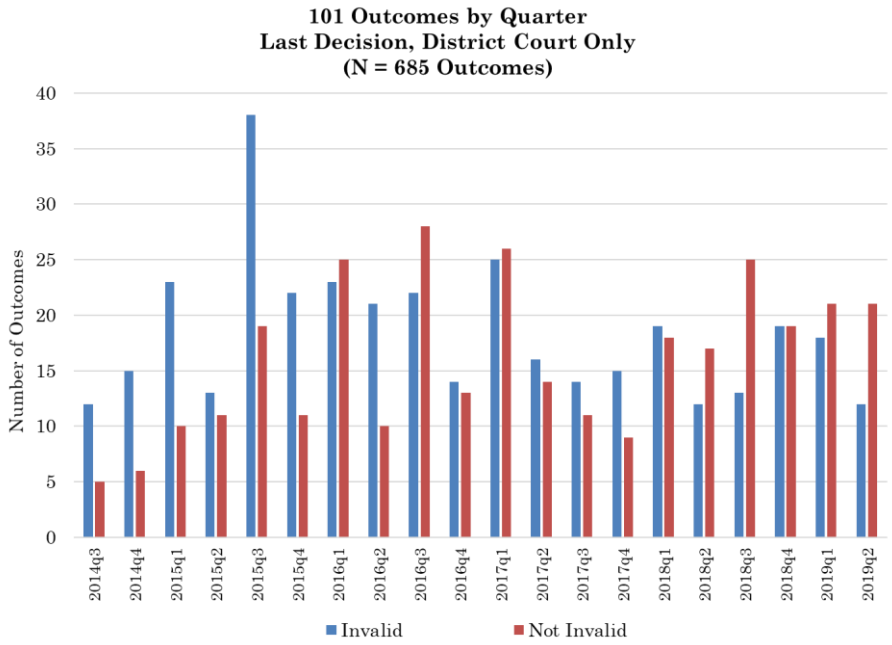
FIGURE 10. OUTCOMES FOR DISTRICT COURT DECISIONS SENT TO FEDERAL CIRCUIT ON APPEAL



Immediately after *Alice*, the Federal Circuit affirmed almost everything, and almost everything presented to it was an invalidation in the district court. As the mix of outcomes appealed began to include more decisions denying invalidity challenges, the Federal Circuit continued to affirm those while starting to remand more district decisions that granted invalidity.

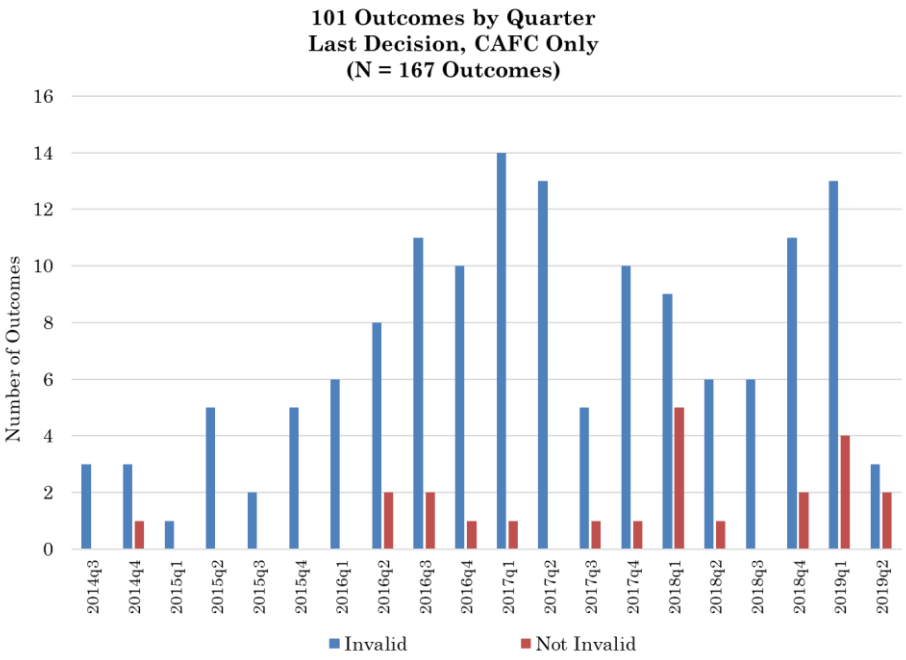
But declining invalidations don't seem to be the whole explanation. District court decisions have been roughly at parity since the beginning of 2016 (Figure 11).

FIGURE 11. DISTRICT COURT DECISION OUTCOMES



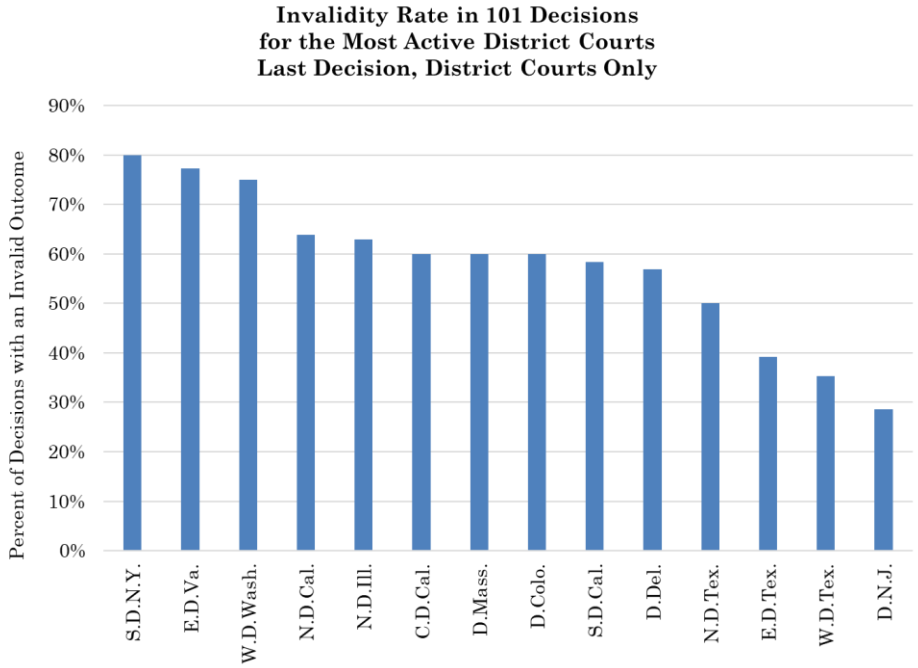
In contrast, while there has been some increase in the Federal Circuit validity rate over time, its decisions remain heavily skewed towards invalidity (Figure 12).

FIGURE 12. FEDERAL CIRCUIT DECISION OUTCOMES



Although the patent invalidity rate varies greatly by district court, the Federal Circuit doesn't seem to be trying to "correct" certain districts. Looking at district courts with 10 or more patent eligibility decisions, the Southern District of NY has found patents invalid in 80% of its decisions but others, like the Eastern District of Texas and the District of New Jersey, have found patents invalid in less than 40% of decisions (Figure 13).[85]

FIGURE 13. INVALIDITY RATE FOR DISTRICT COURTS WITH 10 OR MORE PATENT ELIGIBILITY DECISIONS



Over the history of 101 decisions since *Alice*, the Federal Circuit has only remanded district court decisions 14 times, with no court having more than 2 remanded decisions. More than half of the remanded decisions appear in the top 6 most active

[85] The low invalidation rate courts are not surprising given the Eastern District of Texas' reputation for being plaintiff friendly, the similar reputation of Judge Albright in the Western District of Texas, and the District of New Jersey's high proportion of biotech/life science cases.

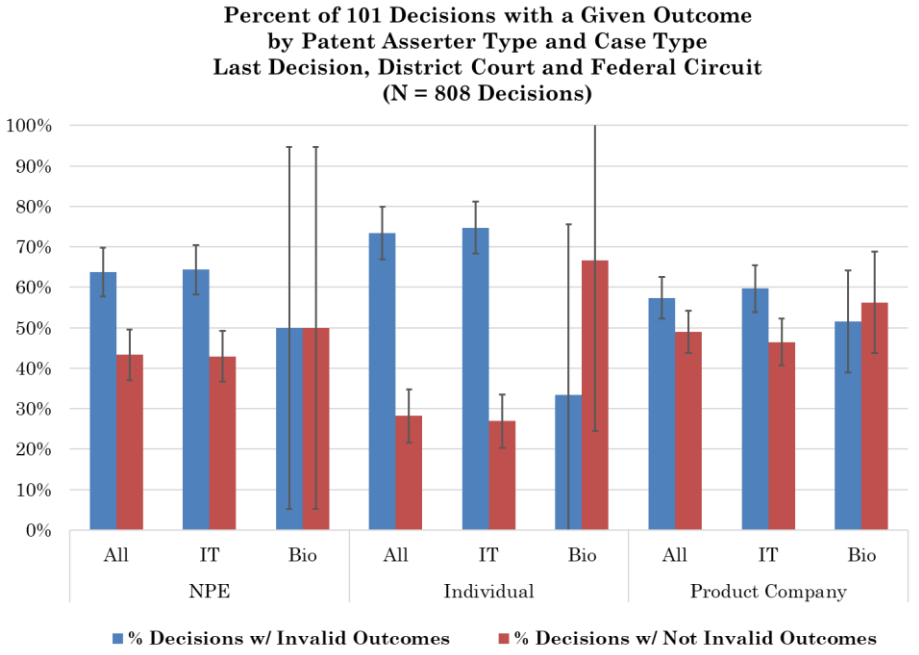
districts like the District of Delaware (152 total decisions), the Eastern District of Texas (110 total decisions), the Northern District of California (91 total decisions), the Central District of California (91 total decisions), the Northern District of Illinois (31 total decisions), and the Eastern District of Virginia (29 total decisions). The average appeal rate is about 25% and most of these districts have appeal rates slightly higher than that, with the exception of the District of Delaware (17% appeal rate) and the Eastern District of Texas (20% appeal rate). Since the number of remanded appeals is so small, it is difficult to say anything definitive, but it appears that the remands are commensurate with the most active courts that send a number of decisions to the Federal Circuit and are not a direct rebuke of any one district. However, districts like Massachusetts and New Jersey are reasonably active (23 and 16 total decisions respectively), but have not been overturned. This may be due to the fact that these districts see relatively more cases brought by product companies than NPEs.

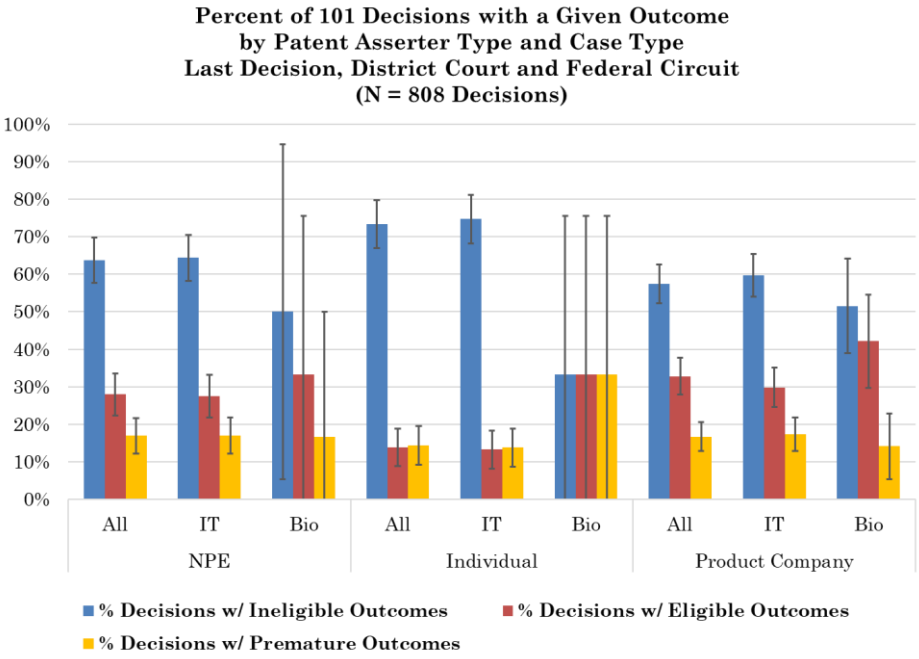
There may be other explanations for the continuing disparity in district court and Federal Circuit invalidation rates. For example, it may be that the parties settle cases at different rates depending on how the district court rules, or that different patentees appeal at different rates. But as we will see in the next section, the observable characteristics such as entity status don't explain away the high invalidation rate at the Federal Circuit.

E. Combining Industry, Entity Status, and Venue

The intersection of industry, entity status, and venue allows us to draw some conclusions about what is driving our results. One of the most striking findings is that individual inventors have a very low win rate as compared to product companies and other NPEs, but this seems to be primarily a software/IT phenomenon as almost no individuals appear in court for biotech/life science cases. Figures 14A and 14B show the percent of decisions with Invalid or Not Invalid outcomes (Ineligible, Eligible, or Premature in Figure 14B) by entity type and industry. NPEs (here defined as all entity types except for Individuals or Product Companies) face Invalid outcomes in Software/IT decisions more often than in Biotech/Life Science decisions, where they face even odds. The trend is similar but less pronounced for Product Companies. Individual asserters have very different results by industry, though. They are far more likely to face a patentable subject matter invalidation in a Software/IT case.

FIGURES 14A AND 14B. DECISION OUTCOMES BY INDUSTRY AND ENTITY TYPE[86]





86 Error bars in both figures represent two standard errors.

To test this rigorously, we ran a series of logit regressions[87] showing the likelihood of receiving an Invalid decision outcome while controlling for various factors in our study simultaneously. We present the results in Table 7.

TABLE 7. LOGIT REGRESSIONS OF RECEIVING AN INVALID DECISION OUTCOME ON INDUSTRY, ENTITY TYPE, AND COURT

	(1)	(2)	(3)	(4)	(5)	(6)
DV =	Invalid	Invalid	Invalid	Invalid	Invalid	Invalid
NPE	0.234	0.122	0.189	0.211	0.211	0.305
(definition varies)	(0.158)	(0.179)	(0.185)	(0.201)	(0.212)	(0.222)
Individual		0.564***	0.582***	0.712***	0.712***	0.725***
		(0.207)	(0.212)	(0.224)	(0.233)	(0.234)
University						-1.332
						(0.951)
Other Asserter						0.147
						(0.518)
Software/IT	0.647**	0.630**	0.560**	0.514*	0.514**	0.473*
	(0.260)	(0.261)	(0.267)	(0.267)	(0.262)	(0.264)
CAFC Decision	1.799***	1.790***	1.885***	1.871***	1.871***	1.885***
	(0.260)	(0.261)	(0.264)	(0.268)	(0.258)	(0.259)
Top 3% of Asserters				-0.574***	-0.574***	-0.593***
				(0.194)	(0.211)	(0.211)
Top 3% of Asserters				0.909**	0.909**	0.873**
in 101 Cases				(0.366)	(0.364)	(0.363)
Case Involves 5+ Patents				0.038	0.038	0.010
				(0.177)	(0.187)	(0.188)
Constant	-0.426*	-0.449*	0.212	0.374	0.374	0.393
	(0.240)	(0.243)	(0.559)	(0.583)	(0.581)	(0.585)
FE	None	None	Quarter	Quarter	Quarter	Quarter
Errors	Robust	Robust	Robust	Robust	Cluster	Cluster
Observations	808	808	808	805	805	805
Pseudo R^2	0.074	0.079	0.110	0.122	0.122	0.127
Case Groups					624	624
Chi^2	61.48	64.12	93.23	94.52	100.77	105.25
Log Likelihood	-492.66	-489.85	-473.25	-464.73	-464.73	-462.46

Robust standard errors in parentheses; Errors clustered by 624 case groups in models (5) and (6)
Based on 101 Decisions in District Court and Federal Circuit issued July 2014 - June 2019, no PTAB
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

87 We choose to use logit models for our analysis because the outcome of interest, whether the decision invalidated a patent under 101 or not, is measured as a binary response (i.e., the statement is true or false). Logits account for the fact that there are only two possible responses and not a continuous set.

Each model in Table 7 uses the variable Invalid (whether a decision contained an invalid outcome or not) as the dependent variable and uses robust standard errors.[88] Our definition of NPE varies by model to highlight the importance of breaking out different entity types. For example, in Model 1, we assume that NPEs are any asserters that are not Product Companies. Here, NPEs are not significantly more likely to face invalidation than Product Companies (the comparison group). Instead, the most important factors to the likelihood of getting a patentable subject matter invalidation are the decision coming from the Federal Circuit or the patents being in the Software/IT industry.

Model 2 first highlights the fact that individual inventor status is a strong, statistically significant factor associated with invalidity as compared with Product Companies and other NPEs. This fact remains true even after we control for the drop in the invalidity rate that occurred over time (Model 3), introduce additional variables regarding asserters' previous litigation behavior and patent portfolio in the lawsuit (Model 4), or cluster our standard errors on the same case to account for the fact that decisions from the same case and are not independent observations (Model 5).[89] In all these models, decisions from the Federal Circuit and those involving Software/IT patents remain significant indicators as well.

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88 This is a standard way of adjusting for heteroskedasticity (where the error term of the model varies over different values of the dependent variable).

89 Typically, multivariate regressions assume that all observations are independent from each other. Despite a *de novo* review, the Federal Circuit's decisions are generally not completely independent from the district court ruling. To account for this, we cluster our standard errors by case since our dataset construction allows the cases to be treated independently.

Our preferred specification (Model 6) includes all previous variables and clusters the standard errors by case, but also further breaks out the asserter types into PAE Only (labeled NPE in Table 6), Individual, University, and Other Asserter with Product Companies being the comparison group.[90] This specification shows that, compared to Product Companies (and controlling for other asserter types), being an individual inventor significantly increases the likelihood of invalidation on patentable subject matter grounds regardless of what other factors we consider. Although logit coefficients are notoriously difficult to interpret, the average marginal effect suggests that being an individual asserter increases the probability of an invalid outcome by almost 14 percentage points all else equal.[91] Being a PAE, by contrast, does not. Software/IT patents are also significantly more likely to face an invalid outcome. Being in the Software/IT industry versus any other increases the probability of an invalid outcome by almost 10 percentage points, based on average marginal effects.[92] And even after taking those factors into account,

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90 We note that our statistically significant results could be due to a false discovery rate (i.e., our results are statistically significant by random chance). This can happen when multiple tests are run from the same dataset, making results with lower levels of significance more questionable. Generally, we are not too concerned about the false discovery rate as our results, especially for individuals, hold over many different models. However, we also calculate Bonferroni-adjusted p-values on our preferred specification (Model 6) to try to account for the false discovery rate (using STATA test with mtest(Bonferroni) option). The adjustment is very conservative, using as the new threshold the standard level of significance (alpha = 0.05) divided by the number of tests. Even with the more conservative adjustment, our significant results remain significant at least at a 95% level.

91 This is significant at the 99% level. Average marginal effects are calculated by changing the variable of interest from 0 to 1 while holding the values of the other covariates as observed. Conducted using the margins, dydx(var) command in STATA after the logit specification in Model 6.

92 This finding is less statistically significant (only at the 90% confidence level).

appearing before the Federal Circuit is significantly related to invalidity.[93] Being at the Federal Circuit increases the probability of an invalid outcome by 31 percentage points, based on average marginal effects.

A final set of interesting results from the logit regression in Model 6 comes from our efforts to determine whether repeat players behave differently and whether they end up driving our results. We identified two different sets of repeat players: asserters that were in the top 3% of all patent asserters, measured by the number of cases filed as reported in the NPE Litigation Database, and asserters in the top 3% in *our* dataset (that is, the patent owners with the most patentable subject matter challenges that went to judgment in the last five years). The results were very different for the two groups. The companies that brought the most lawsuits were significantly less likely to have their patents invalidated on subject matter grounds, a decrease in the probability of an invalid outcome by almost 12 percentage points. But the companies facing the most section 101 challenges were also significantly more likely to lose those challenges (an increase in the probability of an invalid outcome by almost 16 percentage points). That may be a function of greater sophistication among repeat litigants about *Alice* and what patent to assert, and overclaiming on the part of some parties whose patents are challenged repeatedly on subject matter grounds. Notably, though, while both factors are statistically significant, they do not eliminate the separate significance of other factors like individual inventor status.

[93] Confidence in this result is quite high, over 99.9%.

We also run a number of alternative plausible models to make sure our main results are not merely due to the specification we believe is the best. Our robustness checks are shown in Table 8. The first addresses the concern that, despite controlling for whether a decision is issued by the Federal Circuit, we are double counting by including both district court and appellate decisions and overstating the invalidity rate. Table 8, Model 1 runs the same specification in Table 7, Model 6 but only for the last decision in a case that came from either the district court or the Federal Circuit if appealed. Although the coefficient on individual inventors is slightly smaller, it is still statistically significant at the 95% level. The other variables are of similar magnitudes, directions, and significance levels. The primary difference is that the Federal Circuit decisions now make up a larger portion of total decisions, and as we have seen, Federal Circuit decisions mostly invalidate patents, so the *CAFC Decision* variable has a larger effect here.

Since district court and Federal Circuit decisions do have very different invalidation rates, another way to test the robustness of our results is to only look at the district court decisions (Table 8, Model 2). This model has very similar results to our preferred specification with the only exception is that being a software/IT case is no longer statistically significant. Being an individual inventor still increases one's likelihood of getting a patent invalidated in this model though.

Ideally, we would also like to see the additional likelihood an individual inventor with a software/IT patent has of being invalidated. Normally, we could add an interaction term for Individual and the Software/IT dummies. Since there

are so few biotech/life sciences and other decisions, however, there is not enough data in the comparison groups for us to include this interaction term. But we can try to understand how an individual would fare with Software/IT patents by restricting the dataset to Software/IT decisions. Table 8, Model 3 focuses on the last decision in district court and the Federal Circuit as in our preferred specification, but only uses Software/IT cases. Again, the results are largely similar, which is not surprising given that software/IT cases make up the vast majority of our dataset.

Finally, because a large number of cases go through the Eastern District of Texas and they have a low invalidity rate, we added a control variable to account for decisions out of the Eastern District of Texas. As Table 8, Model 4 shows, being in the Eastern District of Texas is far less likely to result in a patent being invalidated. Including a control for the Eastern District of Texas also increases the likelihood (and significance) that PAEs and Individuals will have their patents invalidated anywhere else. However, we interpret these results with caution since PAEs and Individuals tend to appear in the Eastern District of Texas, so the independent variables are highly correlated and can cause bias in the coefficients.[94]

[94] We also considered including a dummy variable for the most active district courts, but data limitations made that infeasible.

TABLE 8. LOGIT REGRESSIONS, ROBUSTNESS CHECKS

DV =	(1) Invalid, Case Last Decision	(2) Invalid, Only District Court	(3) Invalid, Only IT Decisions	(4) Invalid, All Last Decisions
PAE Only	0.229	0.249	0.254	0.591***
	(0.244)	(0.222)	(0.225)	(0.219)
Individual	0.600**	0.771***	0.747***	0.949***
	(0.260)	(0.242)	(0.241)	(0.233)
University	-1.548	-1.258	-1.212	-1.414
	(1.134)	(0.889)	(1.094)	(0.912)
Other Asserter	-0.303	0.245	0.215	0.218
	(0.622)	(0.572)	(0.541)	(0.519)
Software/IT	0.597*	0.295		
	(0.333)	(0.286)		
CAFC Decision	2.400***		2.055***	1.873***
	(0.277)		(0.307)	(0.267)
ED Texas Decision				-1.123***
				(0.270)
Top 3% of Asserters	-0.479**	-0.6145***	-0.540**	-0.508**
	(0.225)	(0.210)	(0.225)	(0.217)
Top 3% of Asserters in 101 Cases	0.532	1.021***	0.882**	1.056***
	(0.380)	(0.384)	(0.368)	(0.373)
Case Involves 5+ Patents	0.165	0.016	-0.107	0.039
	(0.209)	(0.191)	(0.199)	(0.186)
Constant	0.024	0.486	0.832	0.702
	(0.629)	(0.597)	(0.584)	(0.552)
FE	Quarter	Quarter	Quarter	Quarter
Errors	Cluster	Cluster	Cluster	Cluster
Observations	651	643	721	805
Pseudo R^2	0.171	0.071	0.123	0.144
Case Groups	624	610	556	624
Chi^2	108.97	53.20	79.99	115.57
Log Likelihood	-370.16	-408.52	-408.82	-453.50

Robust standard errors in parentheses; Errors clustered by case groups
Based on 101 Decisions in District Court and/or Federal Circuit issued July
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

IV. Implications for the *Alice* Debate

Our results have important implications for the ongoing policy debate over reform to patentable subject matter. They complicate both the case for reform and some of the defenses of *Alice*. On the one hand, things do not look as bleak for the medical diagnostics and genetics industries as they often make out, at least in court. Courts tend to apply *Alice* and related cases primarily in the Software/IT industry. Decisions in Biotech/Life Science cases represent less than 10% of the total, and a majority of those find patents valid. That doesn't mean there are no worrisome decisions that will adversely impact players in the industry, or that it might not affect innovation incentives there,[95] but it is notable that most of the impetus for *Alice* reform may be a reaction to a very small subset of the decisions.[96]

On the other hand, the pro-*Alice* narrative that it is enabling quick and cheap invalidations of abusive patent troll cases isn't fully borne out either. While PAE and non-individual NPE patents are somewhat more likely to fail under *Alice* than practicing entity patents, the difference is not statistically significant. A large fraction of practicing entity patents in the Software/IT industry are invalidated too.

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95 There is actually reason to question whether that is true. Colleen Chien and Arti Rai have studied the effect of patentable subject matter on the medical diagnostics industry and find no significant reduction in patenting or investment, see Colleen V. Chien & Arti K. Rai, *An Empirical Analysis of Diagnostic Patenting Post-Mayo* 3–4 (Jan. 16, 2018) (unpublished manuscript) (on file with authors).

96 We caution again that our results don't necessarily translate to the process of obtaining patents at the PTO. That is particularly true because in January 2019 the PTO adopted guidelines for examining patentable subject matter that diverge significantly from the case law. United States Patent and Trademark Office, 2019 Revised Patent Subject Matter Eligibility Guidance, 84 Fed. Reg. 50 (Jan. 7, 2019).

The biggest effect is on a group that not received as much attention in the *Alice* debates: individual inventors and inventor-started companies, both of which fare quite poorly under *Alice*. That could be a good thing (if we think those suits are on weak patents or are overclaiming) or a bad thing (if it reflects something other than the merits). Certainly some individual inventors have felt that they are not faring well at the patent office and some in Congress seem to be listening. In December 2019, a new House bill (the Inventor Rights Act) was introduced with the intent of strengthening individual inventor patent rights.[97]

Further research, therefore, would profitably focus on understanding why individual inventors do so much worse than others in 101 court challenges and whether that reason is consistent with the goals of the patent system. One possibility is that the patents are worse. Even if that's true, it matters *why* they are worse. If it reflects less useful inventions – say, patent claims that are more abstract because the individual inventor never built a working system – we should be happy that those patents are being invalidated. But it is also possible that the patents are worse even though the inventions aren't. Individual inventors presumably have less money and often less sophistication in the patent system. They may have inadvertently written worse patents more likely to be invalidated. That seems more problematic (though it is also likely to be a more general problem than just patentable subject matter).

97 See Ryan Davis, *New Bill Aims to Strengthen Patents Owned by Inventors*, Law360 (December 18, 2019) (https://www.law360.com/publicpolicy/articles/1228910).

Perhaps the problem isn't with the patents but with the lawsuits. Individual inventors may hire worse lawyers to enforce patents as well as to write them, and may lose because those lawyers are not as good at navigating the shifting and inconsistent patentable subject matter precedent. That too doesn't seem socially desirable, but it also doesn't seem like and *Alice*-specific problem.

It is also possible, however, that individual inventors have deliberately chosen to draft and enforce patents that turn out to be more vulnerable to patentable subject matter challenges. It is well established that inventors overvalue their own contributions.[98] That may translate into broader, more abstract claims asserted against an entire industry. And since the plaintiffs never made it to market, they may rely more on their patents even as the law changes in a way that makes those patents more suspect. Practicing entities and professional licensing shops like PAEs, by contrast, may be more resilient to changes in the patent system. They can simply find different patents to assert or adjust their prices. If this is the explanation, *Alice* is doing a good thing by weeding out patents that overclaim, and doing it more quickly and cheaply than its alternatives.

We emphasize that we cannot definitively explain why individual inventors fare so poorly (or why the Federal Circuit invalidates so many more of their cases). But the evidence complicates the narrative around *Alice* patent reform, and may

98 Christopher Buccafusco & Christopher Jon Sprigman, *The Creativity Effect*, 78 U. CHI. L. REV. 31, 52 (2011). See also Christoph Fuchs, et al., T*he Ideator's Bias: How Identity-Induced Self-Efficacy Drives Overestimation in Employee-Driven Process Innovation*, 62 Acad. Of Mgt. J. 1498 (2019).

suggest that we need a more nuanced, industry-specific rule than some have advocated.