**Article**

# Eligible Subject Matter at the Patent Office: An Empirical Study of the Influence of *Alice* on Patent Examiners and Patent Applicants

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## INTRODUCTION

In May 2019, Senators Tillis and Coons and Representatives Collins, Johnson, and Stivers drafted a bill to reform 35 U.S.C. § 101 of the Patent Act to address issues related to patent eligibility.[1] Since the Supreme Court ruling in *Alice Corp. v. CLS Bank*,[2] the industry has been confronting uncertainties in the prosecution of patent applications and in patent enforcement as a result of the law governing patent eligibility, which arguably harms innovation.[3] In the next year or two, Congress is once again likely to be under pressure to address eligible subject matter reform, as the U.S. Supreme Court has recently chosen not to revisit this topic by denying certiorari in a series of cases involving patentable subject matter in both the software and biotechnology fields.[4]

1. *Sens. Tillis and Coons and Reps. Collins, Johnson, and Stivers Release Draft Bill Text to Reform Section 101 of the Patent Act*, THOM TILLIS U.S. SENATOR FOR N.C. (May 22, 2019), https://www.tillis.senate.gov/2019/5/sens-tillis-and-coons-and-reps-collins-johnson-and-stivers-release-draft-bill-text-to-reform-section-101-of-the-patent-act [https://perma.cc/KU5S-LRDV].

2. Alice Corp. Pty. Ltd. v. CLS Bank Int'l, 134 S. Ct. 2347 (2014).

3. *See* Gene Quinn, *The Road Forward for Software Patents Post*-Alice, IPWATCHDOG (Feb. 25, 2015), http://www.ipwatchdog.com/2015/02/25/the-road-forward-for-software-patents-post-alice [https://perma.cc/UWM5-KL2G].

4. The Supreme Court has recently denied certiorari in these eleven patent eligibility petitions: Berkheimer v. HP Inc., 881 F.3d 1360 (Fed. Cir. 2018), *cert. denied*,

Eligible subject matter in patent law is a threshold requirement of patentability and refers to subject matter that can legitimately be the subject of a U.S. patent.[5] Patent law accepts four categories of inventions—machines, articles of manufacture, compositions of matter, and processes—as properly being the subject of a U.S. patent.[6] By judicial exceptions, however, abstract ideas, natural phenomena, and laws of nature are categorically excluded from patent protection.[7] It has been difficult to define what the three categories of exclusions mean in practice, partly because the meanings of these exclusions are unclear. As a result, courts have struggled to specify legal tests to operationalize these exclusions.

140 S. Ct. 911 (2020); Vanda Pharms. Inc. v. West-Ward Pharms. Int'l Ltd., 887 F.3d 1117 (Fed. Cir. 2018), *cert. denied*, 140 S. Ct. 911 (2020); Athena Diagnostics, Inc. v. Mayo Collaborative Servs., LLC, 915 F.3d 743 (Fed. Cir. 2019), *cert. denied*, 140 S. Ct. 855 (2020); Power Analytics Corp. v. Operation Tech., Inc., 748 F. App'x 334 (Fed. Cir. 2019), *cert. denied*, 140 S. Ct. 910 (2020); Cellspin Soft, Inc. v. Fitbit, Inc., 927 F.3d 1306 (Fed. Cir. 2019), *cert. denied*, 140 S. Ct. 907 (2020); ChargePoint, Inc. v. SemaConnect, Inc., 920 F.3d 759 (Fed. Cir. 2019), *cert. denied*, 140 S. Ct. 983 (2020); Trading Techs. Int'l, Inc. v. IBG LLC, 767 F. App'x 1006 (Fed. Cir. 2019), *cert. denied*, 140 S. Ct. 955 (2020); Trading Techs. Int'l, Inc. v. IBG LLC, 921 F.3d 1084 (Fed. Cir. 2019), *cert. denied*, 140 S. Ct. 954 (2020); SRI Int'l, Inc. v. Cisco Sys., 773 F. App'x 1090 (Fed. Cir. 2019), *cert. denied*, 140 S. Ct. 1108 (2020); Maxell, Ltd. v. Fandango Media, LLC, 779 Fed. App'x 745 (Fed. Cir. 2019), *cert. denied*, 140 S. Ct. 2509 (2020); Reese v. Sprint Nextel Corp., 774 F. App'x 656 (Fed. Cir. 2019), *cert. denied*, 140 S. Ct. 2507 (2020).

Thus, patent eligibility is still a continuing problem unaddressed by the Supreme Court which perhaps opens the door for Congress to act. *See Views from the Top: IP Leaders Sound Off on Supreme Court's Refusal to Wade into Patent Eligibility Debate*, IPWATCHDOG (Jan. 13, 2020), https://www.ipwatchdog.com/2020/01/13/views-from-the-top-ip-leaders-sound-off-on-supreme-courts-refusal-to-wade-into-patent-eligibility-debate [https://perma.cc/HY2U-LUM3] (criticizing the passive reactions of the Supreme Court and the Federal Circuit that will harm the domestic economy and technology development in the U.S., which should be taken care of by Congress); *see also* Gene Quinn, *A Window Is Open to Save U.S. Patents—Don't Let It Slam Shut*, IPWATCHDOG (Feb. 2, 2020), https://www.ipwatchdog.com/2020/02/02/window-open-save-us-patents-dont-let-slam-shut [https://perma.cc/7EVD-UUFR] (urging Congress to handle the chaos about patent eligibility caused by the judicial system for innovation).

5. SHUBHA GHOSH, RICHARD S. GRUNER & JAY P. KESAN, INTELLECTUAL PROPERTY: PRIVATE RIGHTS, THE PUBLIC INTEREST, AND THE REGULATION OF CREATIVE ACTIVITY 289 (3d ed. 2016) ("Section 101 of the Patent Act describes the inventions and discoveries eligible for patent protection, also known as 'patentable subject matter.'").

6. 35 U.S.C. § 101 ("Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.").

7. Gottschalk v. Benson, 409 U.S. 63, 67 (1972) ("Phenomena of nature, though just discovered, mental processes, and abstract intellectual concepts are not patentable, as they are the basic tools of scientific and technological work.").

Since 2010, the U.S. Supreme Court has made three forays into defining the judicial exclusions in *Bilski*, *Mayo*, and *Alice*.[8] These cases motivated the drafting of the "Coons-Tillis" bill to reform § 101 of the Patent Act.[9] Most recently, in 2014, the U.S. Supreme Court addressed the abstract ideas exception and outlined a two-part test for determining the scope of patent-eligible subject matter in *Alice*.[10] In the first step, the Court asks whether the patent claim at issue is or incorporates an abstract idea.[11] If not, the claim is patent-eligible.[12] If the claim involves an abstract idea, however, the second step applies, and the Court asks whether the abstract idea has been transformed into an inventive concept by including additional limitations to the patent claim, thereby rendering the claim eligible for patent protection.[13]

The *Alice* decision has been in effect for over five years.[14] There is significant scholarly debate about whether the current law addressing eligible subject matter after *Alice* creates uncertainties and whether *Alice* fails to provide meaningful guidance. Some scholars worry that the *Alice* framework harms innovation.[15] Because of uncertainties in patenting standards, inventors may prefer to have their innovations protected under trade secret law instead of relying on the current patent regime.[16] Moreover, financiers and venture capitalists

8. Bilski v. Kappos, 561 U.S. 593 (2010); Mayo Collaborative Servs. v. Prometheus Lab'ys, Inc., 566 U.S. 66 (2012); Alice Corp. Pty. Ltd. v. CLS Bank Int'l, 134 S. Ct. 2347 (2014).

9. *See Sens. Tillis and Coons and Reps. Collins, Johnson, and Stivers Release Draft Bill Text to Reform Section 101 of the Patent Act*, *supra* note 1 ("No implicit or other judicially created exceptions to subject matter eligibility, including 'abstract ideas,' 'laws of nature,' or 'natural phenomena,' shall be used to determine patent eligibility under section 101, and all cases establishing or interpreting those exceptions to eligibility are hereby abrogated."); Michael Borella, *Senate Subcommittee on Intellectual Property Holds Hearings on Proposed Revisions to 35 U.S.C. § 101*, PAT. DOCS (June 17, 2019), https://www.patentdocs.org/2019/06/senate-subcommittee-on-intellectual-property-holds-hearings-on-proposed-revisions-to-35-usc-101.html [https://perma.cc/S4C6-XRE2] ("The motivation behind the bill and these hearings was the widespread understanding that a series of Supreme Court decisions in the last decade . . . had 'made a hash' of patent eligibility.").

10. *Alice Corp. Pty. Ltd.*, 134 S. Ct. at 2355 (citing *Mayo*, 566 U.S. at 75–80).

11. *Id.*

12. *Id.*

13. *Id.*

14. *Id.* at 2347.

15. *See, e.g.*, Quinn, *supra* note 3 (interviewing Scott Alter who believes that *Alice* is "arguably not a good decision," for it harms innovation incentives and does not reward and protect innovation).

16. *See* Joanna Brougher & Konstantin M. Linnik, *Patents or Patients: Who Loses?*, 32 NATURE BIOTECHNOLOGY 877, 880 (2014) (suggesting that some inventors may have

rely on the predictability of the patent laws and the availability of patent protection to assess the economic viability of the innovations in which they might invest.[17] Accordingly, investors prefer reliable and reasonable expectations regarding the law that governs patent eligibility so they can minimize economic loss and maximize economic efficiency.[18] Not all scholars, however, agree that *Alice* harms innovation. Mark Lemley argues that stringent restrictions preventing the patenting of abstract inventions will result in a more competitive research and development (R&D) environment.[19] Jason Schultz and Brian Love believe that patents are used as a defensive weapon and thus are less likely to be the result of a desire to protect investments in R&D or reward innovation.[20] Joshua Sarnoff is in favor of the current judicial exclusions that protect "the public domain of science, nature, and ideas" from "unwarranted encroachment."[21] These scholarly debates were reflected in the hearings on proposed legislation to reform patent law.[22] It is currently unclear if a bill abrogating *Alice* and

their inventions protected under the trade secret mechanism instead of patent under this circumstance).

17. *See* Ognjen Zivojnovic, *Patentable Subject Matter After* Alice*–Distinguishing Narrow Software Patents from Overly Broad Business Method Patents*, 30 BERKELEY TECH. L.J. 807, 838 (2015) (suggesting that we must weigh the benefit brought by this invention against the social cost of a granted patent).

18. *See* Ben Dugan, *Mechanizing* Alice*: Automating the Subject Matter Eligibility Test of* Alice v. CLS Bank, 2018 U. ILL. J.L. TECH. & POL'Y 33, 41 (2018) (arguing that reasonable and reliable prediction based on *Alice* can save a significant amount of time and cost).

19. Mark A. Lemley, Michael Risch, Ted Sichelman & R. Polk Wagner, *Life After* Bilski, 63 STAN. L. REV. 1315, 1331 (2011).

20. Jason M. Schultz & Brian J. Love, *Brief of* Amici Curiae *Law, Business, and Economics Scholars in Support of Respondents in* Alice Corp. Pty. Ltd. v. CLS Bank International, et al., 4 N.Y.U. J. INTELL. PROP. & ENT. L. 358, 366 (2015).

21. *The State of Patent Eligibility in America, Part I: Hearing Before the Subcomm. on Intell. Prop. of the S. Comm. on the Judiciary*, 116th Cong. 13–23 (2019) (statement of Professor Joshua D. Sarnoff, Professor of Law, DePaul University), https://www.judiciary.senate.gov/imo/media/doc/Sarnoff%20Testimony.pdf [https://perma.cc/R9KQ-C9CX] (criticizing the "Coons-Tillis" bill for harming innovation by its overprotection of patents instead of preserving the public domain).

22. *See* Borella, *supra* note 9; *see also* Jason Rantanen, *Guest Post by Prof. Ghosh: A Fitter Statute for the Common Law of Patents*, PATENTLY-O (Aug. 1, 2019), https://patentlyo.com/patent/2019/08/fitter-statute-patents.html [https://perma.cc/BBQ6-ZQ8X] (arguing that the "Coons-Tillis" bill would limit judicial exceptions to the Patent Act and would likely be found unconstitutional); Brief of 19 Law Professors as Amici Curiae in Support of Petition for a Writ of Certiorari, Sequenom, Inc. v. Ariosa Diagnostics, Inc., 788 F.3d 1371 (Fed. Cir. 2015) (Nos. 2014-1139, 2014-1144) (noting that lower courts have invalidated patents that are legitimate because they have misapplied the *Alice* test).

other judicial exceptions will be enacted, and the widespread concerns about *Alice* persist.

While the *Alice* test for eligible subject matter is most applicable to computer-implemented inventions (i.e., computer software),[23] lower court decisions post-*Alice* show that none of the patent claims in any technology area are spared from review under the *Alice* framework (e.g., an improved high-performance computer memory system).[24] Business methods that are software-implemented and involve the Internet often develop new types of e-commerce.[25] Patents on business methods, a subject area similar to the patent at issue in *Alice*, may be eligible for patent protection, unless they merely involve an abstract idea and are insufficiently tied to a particular real-world implementation.[26] Ognjen Zivojnovic believes that *Alice* kills all pure business methods patents because all business methods patents merely recite an abstract economic practice and simply employ a general purpose computer to implement the business method.[27] Peter Menell agrees that the U.S. Constitution and the Patent Act were not meant to protect business methods.[28] By contrast, Alex Dejean argues that technological applications, such as online shopping, individualized advertising, and automated customer service, led to a transformation in the patent-eligibility of computer-implemented subjects,

23. Tysver Beck Evans, *Applying Step One of the* Alice/Mayo *Test*, BITLAW: GUIDANCE, https://www.bitlaw.com/guidance/patent/applying-step-one-of-Alice-Mayo-test.html [https://perma.cc/68MY-66ZQ] (indicating "[a]ll three of the identified shadow tests seem most applicable to computer-implemented" inventions, although they may be applicable to other areas as well).

24. Hung H. Bui, *A Common Sense Approach to Implement the Supreme Court's* Alice *Two-Step Framework to Provide "Certainty" and "Predictability*,*"* 100 J. PAT. & TRADEMARK OFF. SOC'Y 165, 230 (2018).

25. Nam Kim, S*oftware and Business Method Inventions After* Alice, SHEPPARD MULLIN (Sept. 23, 2016), https://www.intellectualpropertylawblog.com/archives/software-and-business-method-inventions-after-alice [https://perma.cc/64TB-2YCC] ("Business methods refer to methods of doing business, including new types of e-commerce, insurance, banking, etc., often implemented as software in computers and involving the Internet.").

26. Bilski v. Kappos, 561 U.S. 593, 608–09 (2010); *see also* Zivojnovic, *supra* note 17, at 813 (explaining how courts do not approve patent eligibility for software that does not accompany new and useful hardware); Mark A. Lemley, *Software Patents and the Return of Functional Claiming*, 2013 WIS. L. REV. 905, 962 (2013) (noting that most but not all Federal Circuit decisions after *Bilski* have denied software patent claims).

27. Zivojnovic, *supra* note 17, at 827.

28. Peter S. Menell, *Forty Years of Wondering in the Wilderness and No Closer to the Promised Land:* Bilski*'s Superficial Textualism and the Missed Opportunity to Return Patent Law to Its Technology Mooring*, 63 STAN. L. REV. 1289, 1312–13 (2011) ("There is no reason to believe that 'business methods' have become a science or technology fitting the functional patent mold during the course of the past two centuries.").

including business methods.[29] Along the same lines, David Reardon and Gene Quinn urge that *Alice* must be reversed because the transformative characteristics of software are technological in nature.[30]

In addition to software and business methods, *Alice* has negatively impacted patent eligibility in biotechnology (e.g., biocomputing and bioinformatics).[31] Hallie Wimberly suggests that Congress or the Supreme Court should broaden the scope of patent subject matter eligibility because of the high burden placed on biotechnological inventions after *Alice*.[32] The Biotechnology Industry Organization (BIO) and Pharmaceutical Research and Manufacturers of America (PhRMA) both argue that the restrictions on eligible subject matter after *Alice* should be loosened.[33]

The *Alice* test impacts the entire lifecycle of a patent, including patent application preparation, patent prosecution in the U.S. Patent and Trademark Office (PTO), and patent enforcement in the courts and in post-issuance proceedings in the PTO.[34] This creates significant

29. Alex Dejean, *A Critique of the Supreme Court Holding in* Alice Corp v. CLS Bank *with New Rhetoric*, 12 COLLOQUY 52, 59 (2016).

30. David Reardon & Gene Quinn, Alice *is Due for Reversal: Science Proves Its Reasoning Unsound*, IPWATCHDOG (Mar. 21, 2019), http://www.ipwatchdog.com/2019/03/21/alice-due-reversal-science-proves-reasoning-unsound [https://perma.cc/5P36-XY9B] (claiming that all active software is as transformative as "DNA [m]anipulation, a [f]orge, or [p]harmaceuticals").

31. Eugene Kim, *Biotech Patent Eligibility: A New Hope*, 2017 COLUM. BUS. L. REV. 1157, 1160 (2017) ("[T]his framework was used to deny patent eligibility for a non-invasive method of accessing fetal DNA using previously discarded cell-free cffDNA and a method for gene detection by amplifying and analyzing significantly shorter 'non-coding regions known to be linked to the coding region' of interest."); *see also* Ariosa Diagnostics, Inc. v. Sequenom, Inc., 788 F.3d 1371 (2015) (holding that a prenatal fetal DNA test was not patent eligible because it was directed at a natural phenomenon); Genetic Techs. Ltd. v. Merial L.L.C., 818 F.3d 1369 (2016) (holding that a patent for detection of genetic variations was invalid because it was directed at law of nature); Lidia Yamamoto, Daniel Schreckling & Thomas Meyer, *Self-Replicating and Self-Modifying Programs in Fraglets*, 2 BIO-INSPIRED MODELS NETWORK, INFO., & COMPUTING SYS. 159 (2007) ("Artificial chemical computing models are gaining increasing prominence in the design of bio-inspired software with self-organizing and emergent properties . . . .").

32. Hallie Wimberly, Comment, *The Changing Landscape of Patent Subject Matter Eligibility and Its Impact on Biotechnological Innovation*, 54 HOUS. L. REV. 995, 1025 (2017) ("Considering the outspoken dissatisfaction with the strict standard, the time is apt for either the Supreme Court to revisit the matter and broaden the scope of patent subject matter eligibility or for Congress to step in and reiterate the idea that patentable subject matter should be given broad scope.").

33. *Id.* at 1020.

34. Dugan, *supra* note 18, at 41.

uncertainties in all of these proceedings.[35] Paul Gugliuzza and Lemley empirically reviewed 104 Federal Circuit decisions on patentable subject matter after *Alice*.[36] Lemley and Samantha Zyontz also empirically reviewed 808 federal court decisions about patentable subject matter after *Alice*.[37] Data on the impact of *Alice* on patent prosecution are also being updated on blogs by patent practitioners and commentators (e.g., Bilski Blog, IPWatchdog, and the like).[38] That said, there is limited empirical work focusing on the uncertainties in patent prosecution systematically. There are no studies regarding *Alice*'s impact on patent examiners at the PTO in various technology centers, nor on patent applicants' responses to the *Alice* regime or patent applicants' ability to overcome eligible subject matter rejections during patent prosecution.[39]

This Article presents a causal empirical study of *Alice* and carefully explores how *Alice* impacts patent examiners and patent applicants in various technology areas. It considers how patent applicants employ different strategies (e.g., filing amended patent claims, filing new patent applications, or choosing to abandon or never seek patent protection) to overcome PTO rejections for ineligible subject matter by complying with *Alice*. The study deploys data of all the PTO office actions over the five-year period between 2012 and 2016, roughly two years before and after the *Alice* decision in 2014. It covers a total of 4.48 million patent office actions and patentee responses. The study also contains details regarding art units and the specific grounds for the rejections given by patent examiners. Our methodologies include logistic regressions and difference-in-difference (D-i-D) regressions. Logistic regressions are deployed to explore the association between

35. *See* Jasper L. Tran, *Two Years After* Alice v. CLS Bank, 98 J. PAT. & TRADEMARK OFF. SOC'Y 354, 358–59 (2016) (showing statistical evidence that the PTAB and the Federal Circuit invalidated a large proportion of patents after *Alice* under § 101).

36. Paul R. Gugliuzza & Mark A. Lemley, *Can a Court Change the Law by Saying Nothing?*, 71 VAND. L. REV. 765, 767 (2018).

37. Mark A. Lemley & Samantha Zyontz, Does *Alice* Target Patent Trolls? (unpublished manuscript) (on file with authors).

38. *See, e.g.*, Robert Sachs, Alice*: Benevolent Despot or Tyrant? Analyzing Five Years of Case Law Since* Alice v. CLS Bank*: Part 1*, IPWATCHDOG (Aug. 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 [https://perma.cc/ZG37-PEDG] (finding that the *Alice* test has resulted in a significant number of rejections for patent ineligible subject matter and abandoned applications).

39. *But see* Colleen Chien & Jiun Ying Wu, *Decoding Patentable Subject Matter*, 2018 PATENTLY-O PAT. L.J. 1 (Oct. 16, 2018), https://patentlyo.com/media/2018/10/Chien.Decoding101.2018.pdf [https://perma.cc/M3JQ-KH6U] (presenting a statistical analysis of office actions).

the patent claim rejections under *Alice* and statutory rejections given by examiners under 35 U.S.C. §§ 101, 102, 103, and 112(a)–(f). This study also explores the correlation between § 101 rejections and the other statutory rejections because the *Alice* decision implicates novelty, obviousness, written description, enablement, and claim definiteness under the Patent Act. The study deploys D-i-D regressions to explore whether *Alice* results in more § 101 rejections in the software, business methods, and biotechnology areas, and sub-categories within those three areas. Patent applications in the manufacturing sector are selected as the control group because they are rarely rejected under the abstract ideas exclusion and are therefore very unlikely to be affected by *Alice*. The study compares patent applications in the control group with the patent applications in three technology areas—business methods, bioinformatics, and software—and includes broad and narrow definitions for these categories.

The study demonstrates that the U.S. Supreme Court's decision in *Alice* impacts patent eligibility in different technology areas to different degrees. Moreover, the implementation of the decision by the PTO strengthened the effects of the decision. In all three broad technology areas that we studied, applicants received more *Alice* rejections and § 101 rejections after *Alice*; they are positively associated. *Alice* rejections are not always positively associated with other types of statutory rejections, however. Moreover, patent applicants in all three technology areas filed fewer patent applications post-*Alice*, with the greatest reduction occurring in bioinformatics. Patentees adjusted their patenting strategies after *Alice*. Some strategies effectively overcame § 101 rejections, but others did not.

*Alice* places the highest cost of patenting on bioinformatics.[40] Applications for bioinformatics received many more § 101 rejections because of *Alice*, and the applicants also experienced difficulties in overcoming these rejections. Similarly, applications for business methods received more § 101 rejections because of *Alice*.[41] Nevertheless, average applicants in business methods learned from *Alice*, receiving fewer § 101 rejections when they filed applications post-*Alice*. Applicants in the business methods of e-commerce and finance, however, still found it difficult to overcome § 101 rejections both post-*Alice* and when responding to the examiners' initial round of rejections under § 101. *Alice* also imposed varying degrees of cost of patenting for different types of software inventions (e.g., cryptography and security,

40. *See infra* Part III.A.1.

41. *See infra* Part III.A.2.

databases and file management, GUI and document processing, computer architecture, digital and optical communication, computer networks, telecommunications, digital cameras, recording and compression, computer graphics processing, telemetry and code generation, and artificial intelligence (AI)). Some art units related to software faced higher costs of patenting after *Alice*,[42] but *Alice* might not be a direct or significant reason for the increasing uncertainties in other art units related to software. Our empirical results portray a murky picture of how *Alice* plays out in different technology sectors—quite unworkable in several sectors, yet providing predictable guidance in a few areas.

Part I of this Article introduces the eligible subject matter test under *Alice* and explains how it has been implemented by courts and the PTO, including the Patent Trial and Appeals Board (PTAB) and patent examiners in ex parte prosecution. The test for determining whether a patent claim is abstract under *Alice*, thereby falling within a judicial exception to 35 U.S.C. § 101, should not be facially confused with other statutory patentability requirements, such as novelty in § 102 and non-obviousness in § 103. Unfortunately, the *Alice* decision itself creates many uncertainties in this regard, in addition to uncertainties surrounding its application to different types of patent claims and different technological subject matters. Part II discusses our empirical study design, including data and methodology, and analysis. We provide a descriptive analysis of the data and a causal analysis with the regression results. Part III discusses the implications of the empirical results, explaining the effects of *Alice* on the technologies in the areas of bioinformatics, business methods, and software.

## I. THE SUPREME COURT DECISION IN *ALICE CORP. V. CLS BANK*

The Supreme Court's decision in *Alice* has been applied by lower courts and implemented by the PTO.[43] In the process of applying and implementing the law, concerns have arisen about the uncertainties *Alice* created. This Part first explains the *Alice* test and how the PTO has implemented it. Then, it introduces the concerns expressed in previous studies about the impact of *Alice* within the judicial system and

42. *See infra* Part III.A.3.

43. Memorandum from Andrew H. Hirshfeld, Deputy Comm'r for Pat. Examination Pol'y, U.S. Pat. & Trademark Off. to the Pat. Examining Corps (June 25, 2014), https://www.uspto.gov/sites/default/files/patents/announce/alice_pec_25jun2014.pdf [https://perma.cc/GJ7M-WNS4]. *See generally* Gugliuzza & Lemley, *supra* note 36; Alice Corp. Pty. Ltd. v. CLS Bank Int'l, 134 S. Ct. 2347 (2014).

the PTO, including the PTAB, and how the judicial system and the PTO have tried to overcome these concerns.

### A. THE *ALICE* DECISION REGARDING ELIGIBLE SUBJECT MATTER

This Section explains the *Alice* decision and how it has been implemented by the PTO. It deals with the abstract idea exception to patent eligibility with a two-step test, but *Alice* itself does not clearly define what constitutes an abstract idea.[44] The *Alice* opinion also appears to implicate other statutory requirements for patentability such as novelty and non-obviousness.[45] In implementing *Alice*, the PTO provided some steps to define abstract ideas and further specify the *Alice* test.[46]

#### 1. Abstract Idea and Statutory Limits

The U.S. Supreme Court applied a two-step test in *Alice* to determine patent-eligible subject matter under § 101 by employing the concept of a patent-ineligible abstract idea.[47] The first step in the two-step test is to determine whether the claims at issue are directed to patent-ineligible concepts such as laws of nature, natural phenomena, and abstract ideas.[48] If the claims include a patent-ineligible "abstract idea," the second step is to examine whether the claims fail to transform that "abstract idea" into a patent-eligible invention through the addition of an "inventive concept."[49]

The two-step test in *Alice* could arguably be seen as providing greater clarity to patent eligibility standards in harmony with other foreign patent regimes, but in reality, its application comes with many challenges. Under Article 52 of the European Patent Convention (EPC), discoveries, scientific theories, mathematical methods, aesthetic creations, schemes, rules and methods for performing mental acts, playing games, or doing business, programs for computers, and presentations of information, should not be regarded as inventions; however, additional technical features recited in the claims can confer patent eligibility.[50] Although China, Japan, and South Korea treat

44. *See generally Alice Corp. Pty. Ltd.*, 134 S. Ct. 2347.

45. *See infra* Part I.A.1.b–c.

46. *See* 2014 Interim Guidance on Patent Subject Matter Eligibility, 79 Fed. Reg. 76,418 (proposed Dec. 16, 2014) (to be codified at 37 C.F.R. pt. 1).

47. *Alice Corp. Pty. Ltd.*, 134 S. Ct. at 2352.

48. *Id.* at 2355 (citing Mayo Collaborative Servs. v. Prometheus Lab'ys, Inc., 566 U.S. 66, 75–78 (2012)).

49. *Id.* at 2357 (quoting *Mayo*, 566 U.S. at 72–73).

50. Bui, *supra* note 24, at 267.

computer-related inventions and business methods slightly differently, they treat all patent applications similar to Europe, i.e., as being eligible if "technical characteristics" are present.[51]

Compared to the patent laws in countries that focus on industrial applicability for defining eligible subject matter, the two-step test in *Alice* is hardly a bright line rule that delineates what subject matter is patent-eligible and what is not.[52] As a result, even though the four statutory categories of inventions (e.g., process, machine, manufacture, or composition of matter) recited in § 101 are clear, the "abstract idea" exception under *Alice* renders the application of § 101 vague and uncertain.[53]

*a. "Abstract Idea" as a § 101 Issue*

The U.S. Supreme Court in *Alice* did not define the precise scope of the categories of "abstract ideas" or explain how to determine whether the patent claim contained an "abstract idea."[54] The vagueness of the concept of "abstract idea" may be traced back to Article I, Section 8, Clause 8 of the U.S. Constitution, which is the basis for providing exclusive rights for inventions and creations and for § 101.[55] Malla Pollack points out that this Article itself does not explain how one decides which discoveries promote the progress of the useful arts.[56]

Scholars such as Shubha Ghosh, Richard Gruner, and Jay Kesan suggest that instead of interpreting § 101 to determine what is patentable, it is better to ask about what is excluded from patentability by

51. *Id.*

52. *See Alice Corp. Pty. Ltd.*, 134 S. Ct. at 2357.

53. *See Sachs*, *supra* note 38.

54. *See Alice Corp. Pty. Ltd.*, 134 S. Ct. at 2357; *see also* Brougher & Linnik, *supra* note 16, at 877–78 (describing how the *Alice* decision is unclear "even to most experienced patent attorneys").

55. *Accord* U.S. CONST. art. 1, § 8, cl. 8 ("To promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries."); 35 U.S.C. § 101 ("Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title."). *See generally* Malla Pollack, *What Is Congress Supposed to Promote?: Defining "Progress" in Article I, Section 8, Clause 8 of the United States Constitution, or Introducing the Progress Clause*, 80 NEB. L. REV. 754, 755–59 (2001) (suggesting that the original problems in front of courts are created by the term "progress" in the Constitution).

56. Pollack, *supra* note 55, at 755–59, 770–71 (explaining what "progress" in Article I of the Constitution means but realizing that people do not understand the language in both legislation based on this Article and in judicial proceedings).

§ 101.[57] Other commentators like Annal Vyas and Ilija Ilijovski think that the concept of "abstract idea" should be directly rejected by the Supreme Court or amended by Congress.[58] Still others suggest that if a claim uses computers merely as a tool (e.g., describes some desired outcome, or starts with data, then applies an algorithm and reports some results), then the claim should be ineligible.[59] Thus, there are significant concerns regarding what "abstract idea" means in *Alice*, and how to apply the *Alice* test to overcome this hurdle to patent eligibility.[60]

*b. Abstract Idea, Preemption, and § 112*

The Supreme Court created judicial exceptions to § 101 in *O'Reilly v. Morse* to avoid the preemption of natural laws and fundamental concepts, and accordingly kept laws of nature, natural phenomena, and abstract ideas excluded from patentability.[61] Preemption issues are raised when the scope of protection afforded by the patent claims are potentially so broad and vague that further technological innovation might be preempted by those patent claims at issue.[62] Preemption issues also implicate the requirements of § 112(a) and (b).[63] It may be that the patent claims at issue are so broad that they are not supported

57. GHOSH ET AL., *supra* note 5, at 289 (explaining how to interpret the statutory language in § 101).

58. Annal D. Vyas, Alice in Wonderland v. CLS Bank*: The Supreme Court's Fantastic Adventure into Section 101 Abstract Idea Jurisprudence*, 9 AKRON INTELL. PROP. J. 1, 17–18 (2016) (believing that *Alice* muddled § 101 jurisprudence, which creates uncertainties in patentability); Ilija Ilijovski, *Perfecting U.S. Patentable Subject Matter - Merging the European Approach and the American Principles*, 19 CHI.-KENT J. INTELL. PROP. 178, 185, 204–05 (2020) (proposing that Congress should learn from the E.U. experience and revise the vague language of § 101 to have explicit exclusions).

59. *See* Brougher & Linnik, *supra* note 16, at 880 (arguing that courts are looking for a standard that added-to abstract ideas constitute enough for qualifying patentability).

60. *See* Rob Merges, *Symposium: Go Ask* Alice—*What Can You Patent After* Alice v. CLS Bank*?*, SCOTUSBLOG (June 20, 2014, 12:04 PM), https://www.scotusblog.com/2014/06/symposium-go-ask-alice-what-can-you-patent-after-alice-v-cls-bank [https://perma.cc/QQH3-GVV8].

61. *See* Guy Gosnell & Jim Carroll, CLS Bank Int'l v. Alice Corporation *Provides Little Guidance from Federal Circuit on § 101 Eligibility of Method, Computer Readable Medium, and Computer System Patents*, 130 BANKING L.J. 720, 721 (2013); O'Reilly v. Morse, 56 U.S. 62 (1854) (holding that an "abstract idea" is ineligible for patenting).

62. *See O'Reilly*, 56 U.S. at 113 (describing the danger of permitting overly broad patents).

63. 35 U.S.C. § 112(a)–(b) (specifying requirements for the patent specification regarding its written description, including the requirement for language enabling others "to make and use the same," best mode of use in § 112(a), and the requirements for definiteness of patent claims under § 112(b)).

by the technical disclosure (i.e., the patent specification), raising written description and enablement concerns under § 112(a), or that claims are not sufficiently definite under § 112(b).[64]

The Supreme Court in *Alice* prominently noted the policy concern of preemption raised by abstract patent claims.[65] Joseph Craig notes that the Federal Circuit also requires patent claim specificity to reduce preemption concerns in their eligibility analysis under *Alice*.[66] For example, in *Internet Patents Corp. v. Active Network Inc.*, the Federal Circuit held that an invention directed at a solution to the technical problem of data loss in browsing websites failed to claim a technical solution in sufficiently concrete terms to limit preemption, thereby rendering it patent-ineligible under *Alice*.[67] Moreover, Andrew Chin highlights the issues of preemption concerns on the software industry.[68] Chin argues that the preemption concerns in *Alice* fail to provide clear guidance for patent-eligibility.[69]

Scholars seem to agree that the interaction between §§ 101 and 112 is not a problem created by *Alice*.[70] A patent may preempt the use of an abstract idea, which may harm inventors and the patent industry.[71] The preemption concern is that non-practicing entities (NPEs) prefer patents that are so broad or vague that they may cover commonly used technologies.[72] As a result, Stephanie Toyos believes that

64. *Id.* (requiring patent applicants to draft a patent description which is precise, concise and that will enable others to make and use the invention); *see also* Lemley et al., *supra* note 19, at 1331 (describing the definiteness concerns of § 112).

65. *But see* Memorandum from Robert W. Bahr, Deputy Comm'r for Pat. Examination Pol'y, U.S. Pat. & Trademark Off. to the Pat. Examining Corps 3 (Apr. 19, 2018), https://www.uspto.gov/sites/default/files/documents/memo-berkheimer-20180419.PDF [https://perma.cc/WSJ8-UDVS] (indicating that the PTO does not require the elements to satisfy § 112(a) in Step B analyses).

66. *See* Joseph A. Craig, *Deconstructing Wonderland: Making Sense of Software Patents in a Post-*Alice *World*, 32 BERKELEY TECH. L.J. 359, 376–77 (2018) (arguing that *Alice* creates uncertainties in the judicial system); *see, e.g.*, McRO, Inc. v. Bandai Namco Games Am. Inc., 837 F.3d 1299, 1314–15 (Fed. Cir. 2016) (ruling that claims should be sufficiently specific to confer patent eligibility).

67. *See* Internet Pats. Corp. v. Active Network Inc., 790 F.3d 1343, 1348 (Fed. Cir. 2015).

68. Andrew Chin, *Software Patenting and Section 101's Gatekeeping Function*, *in* CAMBRIDGE HANDBOOK OF THE LAW OF ALGORITHMS (forthcoming 2020) (manuscript at 15–20).

69. *Id.* at 3, 17.

70. Alice Corp. Pty. Ltd. v. CLS Bank Int'l, 134 S. Ct. 2347 (2014).

71. *Cf.* Bilski v. Kappos, 561 U.S. 593, 611–12 (2010) (denying patents for an abstract idea).

72. *See* James Bessen, *What the Courts Did to Curb Patent Trolling—For Now*, ATLANTIC (Dec. 1, 2014), https://www.theatlantic.com/business/archive/2014/12/

*Alice* limits an NPE's ability to own basic and everyday ideas that are merely implemented with a computer.[73] Likewise, Jeffrey Lefstin argues that the eligibility of patents and other fundamental principles of patentability (i.e., §§ 102, 103, or 112) are historical tools used by courts to deal with the preemption issue.[74] *Alice*, then, was not a reason for excluding patentability because of preemption concerns, but a result of the ambiguous implication of that rationale.[75] Indeed, in recent cases such as *Berkheimer v. HP Inc.*,[76] *Aatrix Software Inc. v. Green Shades Software Inc.*,[77] and *MyMail v. ooVoo*,[78] the Federal Circuit clarified that the determination of patent eligibility under § 101 may require previous construction of critical and disputed claim terms.[79]

*c. Abstract Idea, Inventive Concept, and §§ 102 and 103*

Many scholars note that the Supreme Court in *Alice* decided the issue of patent eligibility under § 101 by bleeding into the novelty and non-obviousness requirements under §§ 102 and 103. John Duffy comments that the judicial exceptions in *Alice* were interpreted liberally and expansively, so as to have the potential to "swallow all of patent law."[80] Additionally, Maria Sinatra suggests that *Alice*'s vague and ambiguous language regarding abstract ideas further blurs and

what-the-courts-did-to-curb-patent-trollingfor-now/383138 [https://perma.cc/5AHM-QTQ5].

73. Stephanie E. Toyos, Comment, *Alice in Wonderland: Are Patent Trolls Mortally Wounded by Section 101 Uncertainty*, 17 LOY. J. PUB. INT. L. 97, 99 (2015) ("*Alice* can be seen as an effort to return the patent system to a balance by limiting NPEs' ability to own basic, everyday ideas.").

74. *See* Jeffrey A. Lefstin, *The Three Faces of Prometheus: A Post-*Alice *Jurisprudence of Abstractions*, 16 N.C. J.L. & TECH. 647, 664–69 (2015) (introducing that the idea of preemption of patents originated from England but is liberally applied by the U.S. courts).

75. *See id.* at 669 (believing that preemption is "not a viable candidate for the role of inventive concept" but is merely a reflection of how the courts apply preemption through inventive concept analyses).

76. Berkheimer v. HP Inc., 881 F.3d 1360, 1370 (Fed. Cir. 2018).

77. Aatrix Software Inc. v. Green Shades Software Inc., 890 F.3d 1354, 1364 (Fed. Cir. 2018).

78. MyMail, Ltd. v. ooVoo, LLC, 934 F.3d 1373, 1375 (Fed. Cir. 2019).

79. *See, e.g.*, *id.* ("Because we determine that the district court erred by declining to resolve the parties' claim construction dispute before adjudging patent eligibility, we vacate and remand.").

80. *See* John Duffy, *Opinion Analysis: The Uncertain Expansion of Judge-Made Exceptions to Patentability*, SCOTUSBLOG (June 20, 2014, 12:46 PM), https://www.scotusblog.com/2014/06/opinion-analysis-the-uncertain-expansion-of-judge-made-exceptions-to-patentability [https://perma.cc/DMG5-8TKC] (believing that the Court did not provide a clear guidance for patent eligibility but made a broad judge-made limitation on patentability).

interjects §§ 102 and 103 requirements into the § 101 analysis.[81] A negative consequence of blurring the eligibility and prior art distinctions in patent law is increased transaction costs in both patent litigation and patent examination, as patent eligibility counterclaims (or through motions to dismiss under Rule 12(c)) and PTO § 101 rejections play an increasingly important role.[82] Indeed, after *Alice*, it is common to see that courts analyze claim terms for judging novelty or non-obviousness under §§ 102 and 103 in order to determine patent-eligibility under § 101.[83] Many district courts have required defendants to argue around novelty/anticipation under § 102 and obviousness under § 103 before a heavy debate over § 101.[84]

By contrast, the PTO does not think that the *Alice* test addresses §§ 102 or 103.[85] Section 102 addresses novelty and § 103 addresses the issue of obviousness, and PTO examiners compare the patent claims to the prior art under those requirements.[86] But those requirements are different from the "additional elements" in the two-step test in *Alice*.[87] Therefore, regardless of whether the Supreme Court further defines what constitutes an "abstract idea" in the future, until then,

81. *See* Maria R. Sinatra, *Do Abstract Ideas Have the Need, the Need for Speed?: An Examination of Abstract Ideas after* Alice, 84 FORDHAM L. REV. 821, 841, 849 (2015) (showing that district courts used the terms of "conventional," "long prevalent," "routine," and "well known" in their decisions citing *Alice*).

82. *See* Schultz & Love, *supra* note 20, at 360, 366 (believing that the substantive conditions of patentability in §§ 102, 103, and 112 have much greater litigation costs compared to the litigation cost with respect to § 101).

83. *See* Robert Sachs, *Twenty-Two Ways Congress Can Save Section 101*, BILSKI BLOG (Feb. 12, 2015), https://www.bilskiblog.com/2015/02/twenty-two-ways-congress-can-save-section-101 [https://perma.cc/4N6T-NKA6] (introducing how a § 101 patent eligibility issue merged with the criteria of other patent statutes, including §§ 102 and 103); Parker v. Flook, 437 U.S. 584, 600 (1978) (Stewart, J., dissenting) (criticizing that patent eligibility in § 101 should not import into its inquiry the criteria in §§ 102 and 103); Diamond v. Diehr, 450 U.S. 175, 211 (1981) (Stevens, J., dissenting) (admitting the failure of the courts in recognizing "the critical difference between the 'discovery' requirement in § 101 and the 'novelty' requirement in § 102").

84. *See* Matthew Bultman, *Gilstrap Changes Playing Field with Patent Eligibility Rule*, LAW360 (Aug. 14, 2019, 7:44 PM), https://www.law360.com/articles/1188573/gilstrap-changes-playing-field-with-patent-eligibility-rule [https://perma.cc/7MME-NY3L] ("There are a number of courts, the Eastern District of Texas included, with local rules requiring defendants to present invalidity contentions based on anticipation and obviousness early on in a case.").

85. *See* Memorandum from Robert W. Bahr, *supra* note 65 ("The question of whether additional elements represent well-understood, routine, conventional activity is distinct from patentability over the prior art under 35 U.S.C. §§ 102 and 103.").

86. *See id.*

87. *See id.*

practitioners may use the PTO's Guidance to determine the scope of eligible subject matter.[88]

2. Implementation by the PTO

On June 25, 2014, six days after the *Alice* decision was issued by the U.S. Supreme Court, the PTO issued Preliminary Examination Instructions in view of this case.[89] The instructions explain that the Supreme Court held that claims involving "abstract ideas," particularly computer-implemented "abstract ideas," are patent-ineligible under § 101.[90] The instructions provide four examples of abstract ideas, learning from the *Alice* decision, including (1) fundamental economic practices, (2) certain methods of organizing human activities, (3) ideas themselves, and (4) mathematical relationships or formulas.[91] The PTO noted that *Alice* is an extension of *Mayo* because the framework of the *Alice* decision was currently being used by the PTO to examine claims involving laws of nature after *Mayo* "but had not been used for claims involving abstract ideas."[92]

In December 2014, six months after *Alice* was decided, the PTO formally implemented the *Alice* decision by issuing Interim Eligibility Guidance (Interim Guidance) to the patent examining corps.[93] The Interim Guidance merges other tests for patent-eligibility issued by the Supreme Court in *Myriad*,[94] *Mayo*,[95] and *Bilski*[96] and develops a two-step test.[97] The first step (Step 1) is to determine if the patent claim is directed to a process, machine, manufacture, or composition of matter so as to be patent-eligible under § 101.[98] If not, the claim is statutorily non-eligible and rejected without consideration of those judicial

88. *See* Brooks Kenyon, *Deference Runs Deep: The Ill Effects of* Alice, B.C. INTELL. PROP. & TECH. F. 6 (2016), http://bciptf.org/wp-content/uploads/2016/03/EiC-Edit-7-pages-Brooks-Kenyon-Spring-2016-Deference-Runs-Deep-The-Ill-Effects-of-Alice-1.pdf [https://perma.cc/3MRY-VZGQ] (introducing the importance of the PTO guidance).

89. Memorandum from Andrew H. Hirshfeld, *supra* note 43.

90. *Id.* at 1.

91. *Id*. at 2–3.

92. *See id.* at 1–2. *See generally* Mayo Collaborative Servs. v. Prometheus Lab'ys, Inc., 566 U.S. 66 (2012).

93. *See* Interim Guidance on Subject Matter Eligibility, 79 Fed. Reg. 76,418 (proposed Dec. 16, 2014) (to be codified at 37 C.F.R. pt. 1).

94. Ass'n for Molecular Pathology v. Myriad Genetics, Inc., 569 U.S. 576 (2013).

95. *Mayo Collaborative Servs.*, 566 U.S. 66.

96. Bilski v. Kappos, 561 U.S. 563 (2010).

97. Interim Guidance on Subject Matter Eligibility, 79 Fed. Reg. at 74,619–21.

98. *Id*. at 74,621.

opinions.[99] The second step is a two-part test (Steps 2A and 2B), which deals with judicial exceptions; it applies when the claims pass Step 1.[100] It compares *Alice* to those three earlier Supreme Court decisions on patent-eligibility issues.[101]

Step 2A in the PTO Interim Guidance determines whether the patent claim is directed to a judicial exception, such as an "abstract idea."[102] The Interim Guidance expands the four examples of abstract ideas in the Preliminary Examination Instructions to many examples of abstract ideas.[103] Notably, "software is not automatically an abstract idea."[104] For software claims that may include an abstract idea, examiners are instructed to further analyze the claim as a whole to determine patent eligibility.[105]

If the claim is directed to an exception for abstract ideas, nature or natural phenomena, or nature-based products, Step 2B is applied to determine whether the claim amounts to significantly more than the relevant judicial exceptions.[106] In Step 2B, if a patent claim as a whole does not recite additional elements that amount to significantly more than the relevant judicial exceptions, the claim is not patent-eligible and is rejected under § 101.[107] If the claim passes Step 2B, it will be further examined under §§ 101 (utility, inventorship, and double patenting), 102 (novelty), 103 (non-obviousness), and 112 (enablement, written description, best mode, and claim definiteness, among others).[108] When a claim is rejected because it falls within a judicial exception, the PTO Interim Guidance requires that the examiners identify the specific judicial exception in the rejection.[109]

Any subsequent office actions on the merits are usually final rejections.[110] However, if examiners reject a patent claim under § 101 after Step 2B, which does not require applicant amendments to the claim, the new grounds for rejection are non-final.[111] Meanwhile, the

99. *Id.*; U.S. PAT. & TRADEMARK OFF., MANUAL OF PATENT EXAMINING PROCEDURE § 2106(I) (9th ed. 2020).

100. *See* Interim Guidance on Subject Matter Eligibility, 79 Fed. Reg. at 74,621.

101. *Id*. at 74,619.

102. *Id*. at 74,622.

103. *Id*.

104. U.S. PAT. & TRADEMARK OFF., *supra* note 99, § 2106.04(a).

105. Interim Guidance on Patent Subject Matter Eligibility, 79 Fed. Reg. at 74,622.

106. *Id.*

107. *Id.* at 74,624.

108. *Id.* at 74,625.

109. *Id.* at 74,622.

110. U.S. PAT. & TRADEMARK OFF., *supra* note 99, § 706.07(a).

111. *Id.*

applicants will then be given an opportunity to respond to the office rejection for those existing claims.[112]

### B. UNCERTAINTIES IN ELIGIBLE SUBJECT MATTER

In practice, practitioners, inventors, and scholars complain about how *Alice* creates uncertainties in patent litigation and prosecution[113] that then harm innovation. This Section first addresses the impact of *Alice* on innovation and then reviews the systems of the federal courts, the PTAB, and the examination approach of the PTO to illustrate the uncertainties imposed by *Alice*. Lastly, this Section explains how those institutions have tried to overcome or mitigate the uncertainties inherent in the *Alice* test.

#### 1. Innovation and Uncertainties Created by the Language of Judicial Exceptions

It is unclear whether the *Alice* decision benefits or harms innovation. Some scholars urge that *Alice* harms innovation. Sinatra believes that the judicial exception of *Alice*, with its "sweeping language," increases the transaction costs for patent applicants at the PTO, which then harms the whole reward system that is designed to spur innovation.[114] Inventors and investors demand clear instruction from courts rather than conflicting and ambiguous decisions.[115] Daniel Cahoy argues that the vague language in *Alice* itself causes uncertainty, deterring investment and harming innovation.[116]

By contrast, some scholars do not think that restrictions on patent eligibility deter innovation. Pamela Samuelson and Jason Schultz urge that patents cannot provide enough of a reward to incentivize innovation in business methods.[117] Sinatra does not believe that the

112. *Id.*

113. *See, e.g.*, Daniel R. Cahoy, *Patently Uncertain*, 17 NW. J. INTELL. PROP. 1, 34–36 (2019). *See generally* Paul Michel & John Battaglia, *Flaws in the Supreme Court's § 101 Precedent and Available Ways to Correct Them*, IPWATCHDOG (Apr. 27, 2020), https://www.ipwatchdog.com/2020/04/27/flaws-supreme-courts-%c2%a7101-precedent [https://perma.cc/F82E-3BJJ] (reviewing the Supreme Court cases concerning patent eligibility and offering ways to improve § 101 jurisprudence).

114. *See* Sinatra, *supra* note 81, at 844, 849–854 (explaining that the Court blurs and interjects § 102 and § 103 rejections into § 101 analysis).

115. *See* Paul Michel, *The Supreme Court Saps Patent Certainty*, 82 GEO. WASH. L. REV. 1751, 1753 (2014) (declaring that the Supreme Court lacks a broader perspective on the interaction between the PTO, courts, inventors, and investors).

116. *See* Cahoy, *supra* note 113, at 32–37.

117. *See* Pamela Samuelson & Jason Schultz, *"Clues" for Determining Whether Business and Service Innovations Are Unpatentable Abstract Ideas*, *in* PERSPECTIVES ON PATENTABLE SUBJECT MATTER 8, 18–19 (Michael Abramowicz, James E. Daily & F. Scott Kieff

uncertainties created by *Alice* harm innovation in software.[118] Instead, she believes that the inefficiency in patent examination created by *Alice* can deter "patent trolls" so as to be efficient in a broader sense.[119] Moreover, the lack of private incentives to encourage innovation in biotechnology or software, as a result of *Mayo* and *Myriad*, may not necessarily harm innovation.[120] Lisa Ouellette suggests that companies are still incentivized by inducement from the public sector, such as tax credits, government direct grants, government contracts, or prizes.[121]

2. Uncertainties in the Federal Courts

The Federal Circuit had introduced a "manifestly evident" standard to evaluate whether a patent claim is a patent-ineligible abstract idea.[122] Samuel Reger believes that this manifestly evident standard can reduce litigation costs when courts apply *Alice*.[123] Practitioners and scholars have presented empirical evidence suggesting the existence of significant uncertainty regarding how *Alice* should be applied by the Federal Circuit and other federal courts when those courts

eds., 2015) (arguing that business methods are not costly and should be under the protection of trade secrets rather than patents).

118. *See* Sinatra, *supra* note 81, at 849 (explaining that the process of patent examination takes too long to provide protection for software, which develops faster than the process of examination).

119. *Id.* "Patent troll" pejoratively refers to companies that acquire patents but do not deploy these acquired patents in research, production, or commercialization and generate income from monetizing said acquired patents by enforcing them or attempting to enforce them against others. Samuelson & Schultz, *supra* note 117, at 27.

120. *See generally* Lisa Larrimore Ouellette, *Patentable Subject Matter and Nonpatent Innovation Incentives*, 5 U.C. IRVINE L. REV. 1115 (2015) (arguing that *Mayo* and *Myriad* harmed patent innovation incentives because of the Court's failure to provide clear guidance on patentable subject matter but that other innovation incentives under the public sector could supplement this failure); Mayo Collaborative Servs. v. Prometheus Lab'ys, Inc., 566 U.S. 66 (2012); Ass'n for Molecular Pathology v. Myriad Genetics, Inc., 569 U.S. 576 (2013).

121. Ouellette, *supra* note 120, at 1125–26 (introducing how the public sectors function to provide innovation incentives).

122. The court controversially held that when it is not manifestly evident that a claim is directed to a patent-ineligible abstract idea, that claim must be deemed patent-eligible subject matter. CLS Bank Int'l v. Alice Corp. Pty. Ltd., 685 F.3d 1341, 1352 (Fed. Cir. 2012).

123. Samuel Reger, *It's Not So Obvious: How the Manifestly Evident Standard Affects Litigation Costs by Reducing the Need for Claim Construction*, 1 TEX. A&M L. REV. 729, 739–40 (2014) (arguing that under the current fact-specific requirements, it may become commonplace for courts to engage in formal claim construction, a costly pre-trial process, to decide whether the requirements of *Alice* are met).

implement the *Alice* decision.[124] For instance, Joe Mullin observed that in the Eastern District of Texas, where NPEs have a higher win rate compared to other districts, *Alice* did not cause this court to rule more frequently against NPEs or "patent trolls."[125] Further, more patents survived post-*Alice*[126] even though the number of patent applications filed by NPEs has recently dropped.[127] Moreover, after Dani Kass reviewed the cost of IP litigation over many years, she concluded that *Alice* contributes to the decrease in patent litigation and the increase in the cost of IP litigation among large companies.[128] Robert Sachs reviewed all federal court decisions from the date of the *Alice* decision to July 1, 2015, and found that federal district courts and the Federal Circuit invalidated 66.1% of all patents and 76.7% of all claims challenged under § 101.[129] Sachs recently extended the data to June 2019 and found that 62% of the cases regarding patentable subject matter in federal district courts and the Federal Circuit invalidated those patents.[130] This rate is slightly lower than the judicial data from four years ago.[131]

Gugliuzza and Lemley reviewed 104 cases on patentable subject matter decided by the Federal Circuit between June 20, 2014, and June 19, 2017.[132] Their data present a tough story for patentees: the Federal Circuit is very likely to invalidate claims based on patentable

124. *See, e.g.*, Gugliuzza & Lemley, *supra* note 36, at 780 (observing the uncertainties in the judicial system by empirically reviewing the case decisions made by the federal circuits after *Alice*).

125. Joe Mullin, *Many Patent-Holders Stop Looking to East Texas Following Supreme Court Ruling*, ARS TECHNICA (Oct. 12, 2017, 2:50 PM), https://arstechnica.com/tech-policy/2017/10/patent-cases-in-east-texas-plunge-more-than-60-percent [https://perma.cc/JXN4-XNJL].

126. *Id.*

127. Mark Curriden, *Patent Filings Plummet in East Texas*, CHRON (May 22, 2018, 5:30 AM), https://www.chron.com/business/article/Patent-filings-plummet-in-East-Texas-12932436.php [https://perma.cc/793P-GWNX].

128. Dani Kass, *IP Litigation More Costly, Risky Than Ever Before, MoFo Says*, LAW360 (Aug. 8, 2019, 9:25 PM), https://www.law360.com/articles/1186755/ip-litigation-more-costly-risky-than-ever-before-mofo-says [https://perma.cc/V9F2-SPGB] ("The actual number of suits is diminishing though, which the firm attributed in part to the U.S. Supreme Court's *TC Heartland* and *Alice* decisions, both of which made it harder for plaintiffs in litigation.").

129. Robert Sachs, *#AliceStorm in June: A Deeper Dive into Court Trends, and New Data on* Alice *Inside the USPTO*, BILSKI BLOG (June 30, 2015), https://www.bilskiblog.com/2015/06/alicestorm-a-deeper-dive-into-court-trends-and-new-data-on-alice-inside-the-uspto [https://perma.cc/XB5H-E6XY].

130. Sachs, *supra* note 38.

131. *Id.*; Sachs, *supra* note 129.

132. Gugliuzza & Lemley, *supra* note 36, at 782.

subject matter in cases appealed from the district courts and the PTAB.[133] Many of those decisions are non-precedential.[134] In thirty-three precedential opinions out of the total 104 decisions reviewed, only seven opinions (21.2%) found the patent at issue to be valid.[135] Of the 104 total decisions, patents in only eight of the decisions (7.7%) were allowed to survive by the Federal Circuit.[136]

The technologies involved in those 104 cases were either information technology (IT) or biotechnology.[137] Gugliuzza and Lemley observed that biotechnology is more likely to survive eligibility challenges post-*Alice* compared to IT.[138] This finding is consistent with another study in which Lemley and Zyontz reviewed 808 decisions on patentable subject matter delivered by the Federal Circuit and the federal district courts.[139] There, federal courts invalidated patents in 65.1% of the 724 software or IT cases, but only invalidated 50% of the seventy-six biotechnology or life science cases.[140]

The above results, however, do not mean that when it comes to biotechnology, federal courts are provided clear guidance under *Alice*. An empirical study by Lemley and Zyontz found that bioscience patents fared better in the courts with respect to eligibility.[141] Looking into the process (i.e., the *Alice*, *Myriad*, and *Mayo* decisions) for how courts determine eligibility in biotechnology,[142] Rebecca Eisenberg found that the policy implications of restrictions on patent eligibility are unclear.[143] Eugene Kim argues that although the Federal Circuit decision in *CellzDirect* helps biotechnology patents not directed at diagnostics, there are significant uncertainties in the decisions regarding diagnosis and the treatment of disease.[144]

133. *Id.* at 783.

134. *Id.* at 802.

135. *Id.* at 782.

136. *Id.* at 787.

137. *Id.* at 774.

138. *Id.* at 790.

139. *See* Lemley & Zyontz, *supra* note 37.

140. *Id.* at 31.

141. *Id.*

142. Mayo Collaborative Servs. v. Prometheus Lab'ys, Inc., 566 U.S. 66 (2012); Ass'n for Molecular Pathology v. Myriad Genetics, Inc., 569 U.S. 576 (2013); Alice Corp. Pty. Ltd. v. CLS Bank Int'l, 134 S. Ct. 2347 (2014); *see also In re* BRCA1- & BRCA2-Based Hereditary Cancer Test Pat. Litig., 774 F.3d 755, 764 (Fed. Cir. 2014).

143. Rebecca S. Eisenberg, *Diagnostics Need Not Apply*, 21 B.U. J. SCI. & TECH. L. 256, 274 (2015).

144. Kim, *supra* note 31, at 1188 ("Although the *CellzDirect* decision might help biotechnology patents that are not diagnostics, there remains tension over the disparity

For artificial intelligence and big data-related innovations, *Alice* and subsequent decisions by the Federal Circuit have cast doubt on whether granted patents and new patent applications can satisfy the still-evolving *Alice* test for patent eligibility.[145] Practitioners believe that *Alice* has dramatically reduced the value of issued patents in particular technologies and changed how patent applications are drafted and prosecuted.[146] That said, some practitioners are confident that the uncertainties imposed by *Alice* will eventually diminish through evolving court decisions or new congressional legislation.[147] Even though AI and big data innovation can still be protected with patents, the uncertainties suggest that patents are not the best mechanism to protect these inventions.[148]

In *Enfish, LLC v. Microsoft Corp.*, a case that is post-*Alice*, the Federal Circuit held that "software can make non-abstract improvements to computer technology just as hardware improvements can."[149] Jerry Suva believes that *Enfish* is a manifestation and application of *Alice*'s legal claim, which further clarifies that improvements to a technological process or to the functioning of the computer itself are patentable.[150] However, even though the Federal Circuit has found several computer patents to be eligible in post-*Alice* decisions such as *Enfish* and *BASCOM*,[151] Kim cautions that the same has not yet happened in biotechnology cases.[152] Even worse, in a recent case, *Electric Power Group LLC v. Alstom S.A.*, the Federal Circuit expanded the first step of the *Alice* test, holding that "collecting information, analyzing it, and displaying certain results of the collection and analysis" is an abstract idea or a combination of "abstract-idea processes."[153]

in decisions regarding diagnosis and treatment of disease."); Rapid Litig. Mgmt. v. CellzDirect, Inc., 827 F.3d 1042 (Fed. Cir. 2016).

145. Douglas H. Pearson, Ognian V. Shentov, Carl A. Kukkonen, Andrew Weiss Jeffries & Patrick T. Michael, *Protecting Artificial Intelligence and Big Data Innovations Through Patents: Subject Matter Eligibility*, JONES DAY (Mar. 2018), https://www.jonesday.com/protecting-artificial-intelligence-and-big-data-innovations-through-patents-subject-matter-eligibility-03-12-2018 [https://perma.cc/Q7U9-D9R2].

146. *Id.*

147. *Id.*

148. *Id.*

149. Enfish, LLC v. Microsoft Corp., 822 F.3d 1327, 1335 (Fed. Cir. 2016).

150. Jerry Suva II, Slayden Grubert Beard PLLC, CLE Presentation at the State Bar of Texas Advanced Intellectual Property Law Course: Patentable Subject Matter Update from the Federal Circuit (Feb. 23, 2017).

151. BASCOM Glob. Internet Servs., Inc. v. AT&T Mobility LLC, 827 F.3d 1341 (Fed. Cir. 2016).

152. *See* Kim, *supra* note 31, at 1181.

153. Elec. Power Grp. LLC v. Alstom S.A., 830 F.3d 1350, 1353–54 (Fed. Cir. 2016).

The Federal Circuit has found it difficult to consistently determine patent-eligibility. In *Athena Diagnostics, Inc. v. Mayo Collaborative Services, LLC*, the Federal Circuit released eight separate opinions regarding the issue of subject matter eligibility: four concurred with the denial of the en banc petition and four dissented from that decision.[154] Some dissenting judges argued that patents on diagnostic kits and techniques should be protected for inventiveness.[155] However, some judges in their concurrences invited the Supreme Court or Congress to fix the law governing patent eligibility.[156] Those disparate opinions broadly suggest that the Federal Circuit judges agree that *Alice* and *Mayo* created confusion.[157] However, the U.S. Supreme Court has repeatedly declined to re-visit the topic of eligible subject matter.[158]

3. Uncertainties at the PTO

The PTAB hears appeals from patent applicants engaged in ex parte prosecution, post-issuance patent validity challenges filed by petitioners, or through the pre-AIA ex parte reexamination system.[159] The current system relies heavily on the Federal Circuit to review the PTAB's decisions on patent validity challenges, and the interaction between the Federal Circuit and the PTAB can bring uncertainties from the courts to the PTAB.[160] Post-issuance, eligible subject matter challenges under § 101 can be raised through mechanisms such as post-

154. Athena Diagnostics, Inc. v. Mayo Collaborative Servs., LLC, 927 F.3d 1333 (Fed. Cir. 2019).

155. *Id.* at 1362.

156. *Id.* at 1337.

157. Athena v. Mayo*: A Splintered Federal Circuit Invites Supreme Court or Congress to Step Up on 101 Chaos*, IPWATCHDOG (July 8, 2019), https://www.ipwatchdog.com/2019/07/08/splintered-federal-circuit-invites-supreme-court-review-athena-v-mayo/ [https://perma.cc/4TJE-UYXL].

158. *E.g.*, *Athena Diagnostics*, 915 F.3d 743, *cert. denied*, 140 S. Ct. 855 (2020); Berkheimer v. HP Inc., 881 F.3d 1360 (Fed. Cir. 2018), *cert. denied*, 140 S. Ct. 911 (2020); Vanda Pharms. Inc., v. West-Ward Pharms. Int'l Ltd. 887 F.3d 1117 (Fed. Cir. 2018), *cert. denied*, 140 S. Ct. 911 (2020); Power Analytics Corp. v. Operation Tech. Inc., 748 F. App'x 334 (Fed. Cir. 2019), *cert. denied*, 140 S. Ct. 910 (2020); Cellspin Soft, Inc. v. Fitbit, Inc., 927 F.3d 1306 (Fed. Cir. 2019), *cert. denied*, 140 S. Ct. 907; (2020); ChargePoint, Inc. v. SemaConnect, Inc., 920 F.3d 759 (Fed. Cir. 2019), *cert. denied*, 140 S. Ct. 983 (2020); Trading Techs. Int'l, Inc. v. IBG LLC, 767 F. App'x 1006 (Fed. Cir. 2019), *cert. denied*, 140 S. Ct. 955 (2020); Trading Techs. Int'l, Inc. v. IBG LLC, 921 F.3d 1084 (Fed. Cir. 2019), *cert. denied*, 140 S. Ct. 954 (2020); SRI Int'l, Inc. v. Cisco Sys., 773 F. App'x 1090 (Fed. Cir. 2019), *cert. denied*, 140 S. Ct. 1108 (2020).

159. 35 U.S.C. § 6(a)–(b); Gugliuzza & Lemley, *supra* note 36, at 783–84.

160. Rochelle Cooper Dreyfuss, *Giving the Federal Circuit a Run for Its Money: Challenging Patents in the PTAB*, 91 NOTRE DAME L. REV. 235, 258 (2015).

grant reviews (PGRs) and covered business method reviews (CBMs) at the PTAB.[161] Inter partes reviews (IPRs), a mechanism within the PTAB to challenge patent validity, are far more numerous than the other mechanisms that challenge patent validity, such as PGRs and CBMs, and far more prevalent than initially predicted by the PTO, but IPRs cannot be employed to raise subject matter eligibility challenges.[162] About 87% of the PTAB petitions challenged patents that were being enforced in district court after a pre-suit investigation.[163] Under these circumstances, the former Federal Circuit Chief Judge Paul Michel believes that *Alice* imposes massive uncertainty over the validity of countless thousands of patents, most of which were issued long before *Alice* or even *Mayo*.[164] Likewise, Federal Circuit Judge Todd Hughes contends that such uncertainties harm the U.S. patent system and innovation ecosystem.[165]

These uncertainties may not be eliminated in the dual systems of the federal courts and the PTO, including the PTAB. Paul Gugliuzza explains that the judicial system and the PTAB adapt different standards of proof and different rules of claim construction (at least for the period of time that is the focus of this study).[166] Gugliuzza criticized the dual proceedings for increasing litigation costs and incentivizing "wasteful procedural maneuvering," thereby exacerbating the uncertainties.[167]

Jasper Tran studied the frequency with which *Alice* was cited by the PTAB and showed that *Alice* was cited in 198 PTAB decisions by June 19, 2015, and 90.8% of those patents were invalidated through

161. *Id.* at 235, 244–49.

162. *Id.* at 246–47, 250 tbl.1.

163. *See id.*; *see also* Saurabh Vishnubhakat, Arti K. Rai & Jay P. Kesan, *Strategic Decision Making in Dual PTAB and District Court Proceedings*, 31 BERKELEY TECH. L.J. 45, 73 (2016) ("[T]he majority (70%) of IPR petitioners have previously been defendants in district court litigations involving the patents they now challenge.").

164. *See* Dreyfuss, *supra* note 160, at 256–58, 275 n.255.

165. See *id.* at 276 (noting uncertainties may "chill innovation").

166. *See* Paul R. Gugliuzza, *Quick Decisions in Patent Cases*, 106 GEO. L.J. 619, 642 (2018) (making comparison of duration between the proceedings taken by the judicial system and the PTAB). *But see* Michael R. Houston & George E. Quillin, *PTAB Aligns Its Claim Construction Standard to* Phillips, *Replacing BRI*, FOLEY & LARDNER LLP (Oct. 10, 2018), https://www.foley.com/en/insights/publications/2018/10/ptab-aligns-its-claim-construction-standard-to-phi [https://perma.cc/ADA3-AZCE] (explaining that in November 2018, the PTAB rejected the broadest reasonable interpretation (BRI) standard for claim construction and adopted the *Phillips* standard for claim construction, which is the same standard as that used by the federal courts (citing Phillips v. AWH Corp., 415 F.3d 1303 (Fed. Cir. 2005) (en banc))).

167. Gugliuzza, *supra* note 166, at 642, 657.

that process.[168] Samuel Hayim and Kate Gaudry studied 500 ex parte appeal decisions for appeals filed post-*Alice* that were within the technology areas of Technology Centers (TCs) 2100, 2400, 2600, and business methods and that were rendered by the PTAB in the two years after *Alice*.[169] They found that a mere 16% of the initial rejections based on patent eligibility were "fully reversed" by the PTAB.[170]

Although it is unclear whether the PTAB should adopt the same criteria as courts, Rochelle Dreyfuss believes that the PTAB can furnish a blueprint for clarifying the uncertainties because a narrow, clear scope of patent claims can reduce the litigation and transaction costs imposed by patent trolls.[171] Moreover, based on their review of a large number of Federal Circuit decisions, Gugliuzza and Lemley predict that there will be no increase in the percentage of patents being upheld in appeals from the PTAB because of the peculiarities of the administrative process.[172] They believe that it is unlikely that the Federal Circuit will hear many appeals challenging the PTAB rulings that confirm patent validity.[173]

4. Previous Empirical Studies of Office Actions by the PTO

Besides the summary statistics that are published on various blogs,[174] the sole empirical work analyzing office actions issued by the PTO was conducted by Colleen Chien and Jiun Ying Wu.[175] Chien and Wu performed a statistical analysis of office actions between 2008 and

168. Jasper L. Tran, *Software Patents: A One-Year Review of* Alice v. CLS Bank, 97 J. PAT. & TRADEMARK OFF. SOC'Y 532, 540 (2015) ("The PTAB has upheld 18 patent applications and invalidated 178 patent applications—an invalidation rate of 90.8%.").

169. Samuel Hayim & Kate Gaudry, *Nearly All Post-*Alice *Eligibility Rejections are Affirmed in Whole by the PTAB*, KILPATRICK TOWNSEND (Feb. 27, 2018), https://www.kilpatricktownsend.com/-/media/Files/articles/2018/Article-1-SHKG.ashx [https://perma.cc/B2CV-89QF]; *see also Patent Technology Centers Management*, U.S. PAT. & TRADEMARK OFF., https://www.uspto.gov/patent/contact-patents/patent-technology-centers-management [https://perma.cc/ES3G-UANS] (outlining that TC 2100 includes computer architecture software and information security, TC 2400 includes computer networks, multiplex, cable and cryptography or security, and TC 2600 includes communications).

170. Hayim & Gaudry, *supra* note 169 (finding that "full affirmances were much more common for applications assigned to a business-method art unit (full affirmances=80%) as compared to TC 2100 (61%), TC 2400 (55%) or TC 2600 (66%)").

171. Dreyfuss, *supra* note 160, at 262.

172. Gugliuzza & Lemley, *supra* note 36, at 794–95.

173. *Id.*

174. *See, e.g.*, Sachs, *supra* note 129.

175. *See* Chien & Wu, *supra* note 39 (exploring the proportion of rejections under § 101 to the office actions for individual Technology Centers after *Alice*).

mid-July 2017 to explore the role of *Alice* in patent examination.[176] They observed that business methods, bioinformatics, and software patent applications were abandoned more frequently when the patentees received a § 101 rejection post-*Alice*.[177] Their analysis indicates an increasing rate of § 101 rejections in the examination of patent applications in business methods, bioinformatics, and particular software technologies.[178] Their results are also consistent with other online summary statistics. For example, in some art units in business methods, final rejection rates under § 101 rose between 35% and 60% after *Alice*, including e-shopping, accounting, business processing, incentive programs, finance and banking, retail, insurance/health care, operations research, and reservations.[179]

In Chien and Wu's empirical study, they counted the numbers of patent applications, § 101 rejections imposed by the PTO, and patent application abandonments by applicants.[180] However, directly observing the fluctuation of these numbers cannot support a conclusion that the abandonments were caused by *Alice*. They also did not indicate how patent applicants adjusted their filing and prosecution strategies post-*Alice*.[181] Our empirical research design with D-i-D analysis presented in this Article observes (1) whether *Alice* was a cause of the § 101 rejections and the decrease in the number of patent applications and (2) whether patent applicants adjusted their filing and prosecution strategies post-*Alice*.

5. Revised Guidance from the PTO to Reduce These Uncertainties

Even though the PTO issued guidelines to implement *Alice*, scholars are split on whether these guidelines may be effective in eliminating the uncertainties arising from applications of the *Alice* test in the courts.[182] Tran is persuaded that the PTO grants software patents if meaningful limitations go beyond generally linking the use of an

176. *See generally id.*

177. *See id.* at 16–17.

178. *See id.* at 17 ("101 is playing an increasingly important role in the examination of software and medical diagnostics patents. . . . [T]he vast majority of inventions examined by the office are not significantly impacted by 101.").

179. Sachs, *supra* note 129.

180. *See* Chien & Wu, *supra* note 39, at 14 (describing their methodology as a descriptive analysis, rather than a diff-in-diff regression analysis, even though the authors termed their work a D-i-D study because a diff-in-diff analysis requires an identification strategy, which the work lacks).

181. *Id.*

182. *Compare* Tran, *supra* note 168, *with* Kenyon, *supra* note 88.

abstract idea to a particular technological environment.[183] By contrast, Brooks Kenyon criticizes the PTO's internal guidelines because they only mirror the Federal Circuit's decisions on software, resulting in an alarmingly high rejection rate.[184] Kenyon predicts that examiners will hesitate to issue patent claims, and such hesitation is premised on the guidelines and orders from their supervisors in the examining core.[185] Indeed, since the *Alice* decision, patent examiners have rejected a staggering number of patent applications in different technology areas under § 101.[186]

In order to provide clear guidance to patent examiners for evaluating subject matter eligibility, the PTO issued Revised Patent Subject Matter Eligibility Guidance (Revised Guidance) in January 2019.[187] The Revised Guidance does not revise the earlier Interim Guidance for Step 1, which pertains to whether the patent claim falls within a statutory category.[188] It only revises Steps 2A and 2B and tries to clarify the judicial exceptions related to *Alice* and *Mayo*.[189]

The revised Step 2A requires more than asking whether the patent claims are abstract ideas or not so as to fall within a judicial exception, as outlined in the earlier Step 2A.[190] It is now a two-prong test that involves allowing patent claims that recite a judicial exception if the judicial exception is then integrated into a practical application.[191] Because of this second prong, examiners are instructed to give weight to all additional elements in the claim, including whether they are conventional when evaluating whether the judicial exceptions are integrated into a practical application.[192]

The goal of Step 2B is clarified in the Revised Guidance to focus on evaluating whether the patent claims provide an inventive

183. Tran, *supra* note 168, at 537, 541–42.

184. Kenyon, *supra* note 88, at 4–5.

185. *Id.* at 5.

186. Michael Stein, *USPTO Urged to Revise Interim § 101 Guidance to Require Examiners to Present a Proper Prima Facie Case Supported by Factual Evidence*, BAKER HOSTETLER: IP INTEL. (Mar. 23, 2015), https://www.ipintelligencereport.com/2015/03/23/uspto-urged-to-revise-interim-%C2%A7101-guidance-to-require-examiners-to-present-a-proper-prima-facie-case-supported-by-factual-evidence [https://perma.cc/R6R7-ZHUV]; *see also* Sachs, *supra* note 129.

187. 2019 Revised Patent Subject Matter Eligibility Guidance, 84 Fed. Reg. 50 (Jan. 7, 2019).

188. *Id.* at 54.

189. *Id.*; *see also* Mayo Collaborative Servs. v. Prometheus Lab'ys, Inc., 566 U.S. 66 (2012).

190. 2019 Revised Patent Subject Matter Eligibility Guidance, 84 Fed. Reg. at 54.

191. *Id.*

192. *Id.* at 55.

concept.[193] An inventive concept may be presented when there are additional elements that add limitations that are not well-understood, routine, conventional activities in the field.[194] It is not enough to present an inventive concept if the additional elements only generate "well-understood, routine, conventional activities previously known to the industry . . . at a high level."[195]

## II. EMPIRICAL STUDY OF THE IMPACT OF *ALICE* ON PATENT PROSECUTION

Does *Alice* create more uncertainties in patent prosecution? What are the nature and the extent of these uncertainties across different technology sectors, including consideration of patentee strategies to overcome *Alice*-based rejections? To explore these questions, this Article develops a causal empirical design to estimate the effect of the *Alice* decision and its implementation by the PTO. This Part first introduces our data and the empirical study design and then explains the various regressions' results. We find that the *Alice* decision affects different technology areas to different degrees, and the ability of patent applicants to file patent applications to better comply with the patent eligibility requirements under *Alice* also varies across technology areas.[196] Thus, patents in some technology areas are more likely to be rejected under § 101 due to *Alice*.[197]

### A. DATA AND METHODOLOGY

This Section introduces our data sources, the coding strategy, and the characteristics of the data. While we have a comprehensive database of PTO office actions, we focus on a few relevant Technology Centers and art units and closely study patent applications filed in the areas of bioinformatics, business methods, and software. These three technologies have received an increasing number of *Alice* rejections, and some of them received significantly more § 101 rejections post-*Alice*.[198]

193. *Id.* at 56; *see also* Memorandum from Andrew H. Hirshfeld, *supra* note 43.
194. 2019 Revised Patent Subject Matter Eligibility Guidance, 84 Fed. Reg. at 56.
195. *Id.*
196. *See infra* Part II.
197. *See infra* Part III.
198. *See* Chien & Wu, *supra* note 39; Sachs, *supra* note 129.

1. Data Sources and Study Objects

For *Alice*, the petition for a writ of certiorari was granted on December 6, 2013.[199] The judgement was issued by the Supreme Court on June 19, 2014.[200] On December 16, 2014, the PTO formally implemented the *Alice* decision by updating its Guidance for patent examiners regarding subject matter eligibility.[201] Our data include every office action issued by the PTO in the period between January 2012 and December 2016 for a total of 4.48 million office actions.[202] The types of office actions include notices of allowances, initial rejections, and final rejections in response to patent applications and amendments filed by patentees.[203] The specific reasons for the rejections of claims include §§ 101, 102, 103, and 112(a)–(f), and references to court decisions in *Alice*, *Myriad*, and *Mayo*.[204] If the rejections are final rejections, applicants can file Requests for Continued Examination (RCEs) to continue prosecution on the merits.[205]

199. *Alice Corporation Pty. Ltd. v. CLS Bank International*, SCOTUSBLOG, https://www.scotusblog.com/case-files/cases/alice-corporation-pty-ltd-v-cls-bank-international [https://perma.cc/HMR5-HB6L].

200. Alice Corp. Pty. Ltd. v. CLS Bank Int'l, 134 S. Ct. 2347 (2014).

201. 2014 Interim Guidance on Patent Subject Matter Eligibility, 79 Fed. Reg. 74,618 (proposed Dec. 16, 2014) (to be codified at 37 C.F.R. pt. 1).

202. *See infra* Parts II.A.2, II.B (data provided by Reed Tech, a LexisNexis company).

203. *See infra* Parts II.A.2, II.B.

204. *See infra* Parts II.A.2, II.B; *see also* Ass'n for Molecular Pathology v. Myriad Genetics, Inc., 569 U.S. 576 (2013); Mayo Collaborative Servs. v. Prometheus Lab'ys, Inc., 566 U.S. 66 (2012); *Alice*, 134 S. Ct. 2347.

205. U.S. PAT. & TRADEMARK OFF., *supra* note 99, § 706.07(h).

Table 1. Variables by Year and All Sample Sizes

| | All Office Actions | Final Rejections | All § 101 Rejections | Final § 101 Rejections |
|---|---|---|---|---|
| 2012 | 1,043,846 | 238,031 | 69,083 | 10,267 |
| 2013 | 787,625 | 200,078 | 38,226 | 8,005 |
| 2014 | 401,930 | 65,023 | 39,230 | 5,142 |
| 2015 | 1,022,696 | 249,092 | 106,436 | 34,767 |
| 2016 | 1,220,784 | 305,225 | 105,203 | 32,512 |
| | Rejections based on *Alice* | All § 102 Rejections | All § 103 Rejections | All § 112 Rejections |
| 2012 | 60 | 306,713 | 550,160 | 227,790 |
| 2013 | 55 | 198,386 | 423,427 | 161,089 |
| 2014 | 4,460 | 152,235 | 211,768 | 106,164 |
| 2015 | 22,148 | 349,693 | 574,238 | 280,619 |
| 2016 | 30,558 | 301,431 | 651,595 | 291,254 |

Table 2. Industry Categories, Art Units, and Number of Office Actions

| Industry | Technology (Art Units) | Number of Office Actions |
|---|---|---|
| Manufacturing Devices | 3722-3727 & 3729 | 73,822 |
| Bioinformatics | 1631 & 1639 | 11,513 |
| Bioinformatics (broad) | 1630 | 60,991 |
| Business Methods | 3600 | 575,009 |
| Business Methods of Finance | 3690 | 33,720 |
| Business Methods of E-Commerce | 3620 & 3680 | 95,583 |
| E-Commerce in Health Care | 3626 & 3686 | 16,233 |
| E-Commerce in Cryptography | 3621 | 4,767 |
| Software (general) | 2100 & 2400 & 2600 | 1,407,377 |
| AI | 2121 & 2129 | 13,303 |
| Graphical User Interface and Document Processing | 2140 & 2170 | 72,825 |
| Data Bases and File Management | 2150 & 2160 | 96,108 |
| Cryptography and Security | 2430 & 2490 | 95,693 |
| Computer Architecture | 2180 & 2110 | 89,717 |
| Digital and Optical Communication | 2630 | 47,608 |
| Computer Networks | 2440 & 2450 | 106,351 |
| Telecommunications | 2640 | 105,440 |
| Digital Cameras | 2660 | 81,209 |
| Recording and Compression | 2480 | 58,912 |
| Computer Graphics Processing | 2610 | 49,165 |
| Telemetry and Code Generation | 2680 | 57,265 |

Table 1 shows the number of office actions between 2012 and 2016 and discloses the specific numbers of rejections under the different statutory requirements and based on *Alice*. Table 2 shows the number of office actions by technology areas, addressing selection bias concerns and supporting the robustness of the empirical analyses. Patent applications are reviewed by patent examiners in

different Technology Centers and art units to assess the technological nature of the invention in the patent applications.[206] Art units are subsets of broader Technology Centers at the PTO.[207]

This study conducts an empirical analysis for three different technology sectors most directly affected by the *Alice* decision—bioinformatics, business methods, and software.[208] It also includes sub-categories within those technology areas (e.g., specific art units within these three sectors).[209] In the bioinformatics sector, this study explores patent applications under two measures. It employs a narrow definition of bioinformatics by choosing specific art units 1631 and 1639 and a broad definition of bioinformatics under the more general art unit 1630.[210] This study also explores patent applications directed at business methods, as defined in TC 3600.[211] It tests some specific art units within TC 3600, including art units 3620 and 3680 for e-commerce and art unit 3690 for finance.[212] E-commerce is further divided into specific art units for health care and cryptography.[213] Finally, this study explores software patent applications, broadly defined as those

206. *Patent Classification*, U.S. PAT. & TRADEMARK OFF., https://www.uspto.gov/patents-application-process/patent-search/classification-standards-and-development [https://perma.cc/3BX6-CHTC].

207. *Id.*

208. *See infra* Parts II.A.2, II.B.

209. *See infra* Parts II.A.2, II.B.

210. *See infra* Parts II.A.2, II.B; *see also Classes Arranged by Art Unit*, U.S. PAT. & TRADEMARK OFF., https://www.uspto.gov/patents-application-process/patent-search/understanding-patent-classifications/patent-classification [https://perma.cc/3BX6-CHTC] (outlining art unit 1631 refers to data processing and art unit 1639 refers to combinatorial chemistry technology); *TC 1600 Management Roster*, U.S. PAT. & TRADEMARK OFF., https://www.uspto.gov/patent/contact-patents/tc-1600-management-roster [https://perma.cc/VP5P-8KXV] (explaining that art unit 1630 refers to the technology sectors of molecular biology, bioinformatics, nucleic acids, recombinant DNA and RNA, gene regulation, nucleic acid amplification, animals and plants, and combinatorial/computational chemistry). *See generally Patent Classification*, U.S. PAT. & TRADEMARK OFF., https://www.uspto.gov/patents-application-process/patent-search/classification-standards-and-development [https://perma.cc/3BX6-CHTC] (explaining the definition of art units relies on the classification provided by the PTO).

211. *See infra* Parts II.A.2, II.B.

212. *See infra* Parts II.A.2, II.B; *see also TC 3600 Management Roster*, U.S. PAT. & TRADEMARK OFF., https://www.uspto.gov/patent/contact-patents/tc-3600-management-roster [https://perma.cc/8MN6-P3XX].

213. *See infra* Parts II.A.2, II.B; *see also TC 3600 Management Roster*, *supra* note 212.

applications in TC 2100, TC 2400, and TC 2600.[214] It also studies specific art units within this broad category for software.[215]

2. Descriptive Analyses

Figure 1 below shows the proportion of PTO rejections citing *Alice* over all office actions issued to patent applications in different technology sectors after *Alice*. Figure 2 below shows the proportion of § 101 rejections over all office actions in different technology sectors. The two figures show the frequency with which patent examiners rejected patent applications for patent ineligibility under *Alice* or § 101. Figures 1 and 2 show that patent applications in bioinformatics (under the narrow definition) received both more rejections that cited *Alice* as a reason (i.e., *Alice* rejections) and more § 101 rejections compared to patent applications in business methods or software. However, the narrower categories in business methods for finance and e-commerce received more *Alice* rejections and § 101 rejections compared to all other technology areas.

In bioinformatics (narrowly defined), 24% of all office actions included *Alice* rejections for patent applications filed before, but examined after, *Alice* was decided by the Supreme Court or implemented by the PTO. This percentage reduced to about 18% for patent applications filed post-*Alice*. Before *Alice* was decided, 23.76% of the office actions for applications in bioinformatics included § 101 rejections. After the *Alice* decision, 60.97% of the office actions included § 101 rejections for applications filed before *Alice* was decided, which then decreased slightly to 58.48% for applications filed post-*Alice*. About 17.9% of the final decisions for bioinformatics included § 101 rejections before *Alice* was decided by the Supreme Court. This rate went

214. *See infra* Parts II.A.2, II.B.

215. *See infra* Parts II.A.2, II.B (highlighting that the specific art units include art units 2430 and 2490 for cryptography and security, art units 2150 and 2160 for data bases and file management, art units 2140 and 2170 for graphical user interface (GUI) and document processing, art units 2180 and 2110 for computer architecture, art units 2630 for digital and optical communication, art units 2440 and 2450 for computer networks, art units 2640 for telecommunications, art units 2660 for digital cameras, art units 2480 for recording and compression, art units 2610 for computer graphics processing, and art units 2680 for telemetry and code generation (first citing *TC 2400 Management Roster*, U.S. PAT. & TRADEMARK OFF., https://www.uspto.gov/patent/contact-patents/tc-2400-management-roster [https://perma.cc/C4T8-TWXT]; then citing *TC 2100 Management Roster*, U.S. PAT. & TRADEMARK OFF., https://www.uspto.gov/patent/contact-patents/tc-2100-management-roster [https://perma.cc/636H-EXHP]; and then citing *TC 2600 Management Roster*, U.S. PAT. & TRADEMARK OFF., https://www.uspto.gov/patent/contact-patents/tc-2600-management-roster [https://perma.cc/3NZU-PMHF])).

up to 72.43% after *Alice* was decided for the applications filed before *Alice* and 72.78% for applications filed after *Alice*.

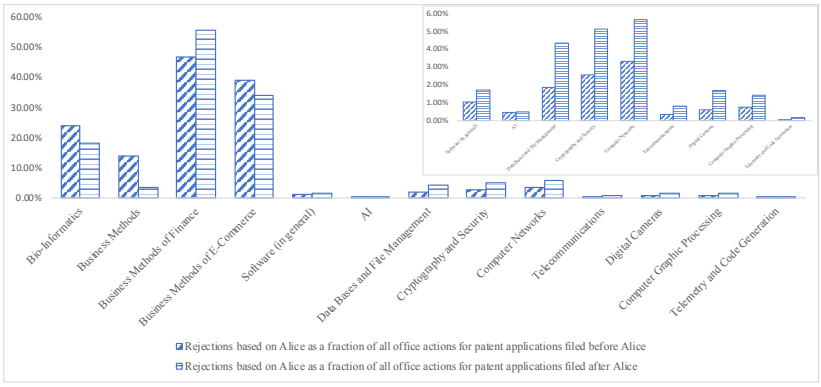


Figure 1. The Proportion of *Alice*-Based Rejections as a Fraction of All Office Actions

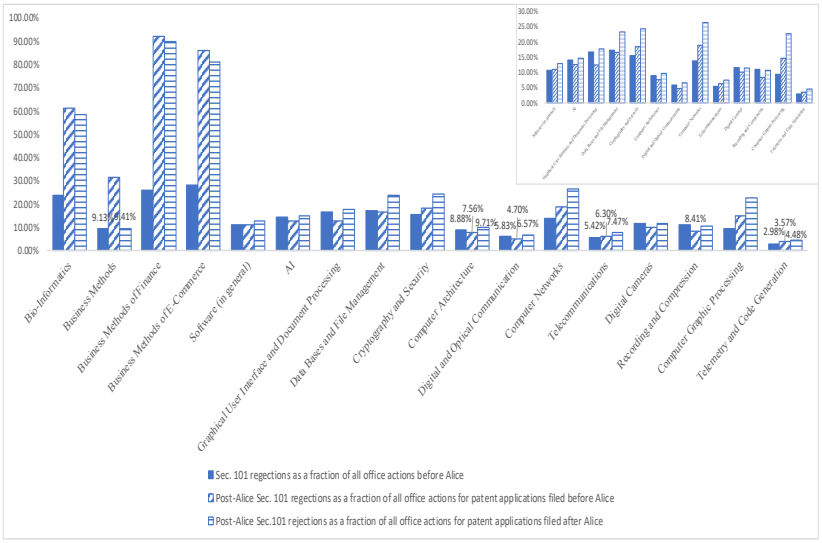


Figure 2. The Proportion of § 101 Rejections as a Fraction of All Office Actions

In business methods, 13.87% of the office actions for applications filed before the *Alice* decision, but examined after the *Alice* decision, cited *Alice* and imposed a rejection. This rate increased slightly to 15.21% for applications filed before *Alice* but examined after the PTO implementation of *Alice*. The rejection rate reduced significantly to

3.49% for business method patent applications filed after *Alice*, and similarly shrank to 3.46% for business method applications filed after the PTO implementation of *Alice*. Thirty-one percent of the office actions for business method patent applications included § 101 rejections before *Alice* was decided; this reduced to 9.41% for those applications filed post-*Alice*. Considering only final office actions, 8.52% of those final decisions (e.g., allowances or rejections) for business methods included § 101 rejections before *Alice* was decided. This rate increased dramatically to 45.44% after *Alice* was decided for applications filed before *Alice* and decreased sharply to 14.11% for patent applications filed after *Alice*.

Software received relatively fewer § 101 rejections and *Alice* rejections compared to both business methods and bioinformatics. In the general software sector, 1.04% of the office actions included rejections under *Alice* for applications filed before *Alice* but examined after *Alice*. This rate increased slightly to 1.17% for applications filed before the *Alice* decision was implemented by the PTO. The rejection rate increased to 1.7% for software applications filed after *Alice* and its implementation by the PTO. Before *Alice* was decided, 10.75% of all office actions for software applications were § 101 rejections. After *Alice*, 10.93% of all office actions for applications filed before *Alice* were § 101 rejections, which then increased slightly to 12.98% for applications filed after *Alice*. Moreover, 6.47% of final decisions (e.g., allowances or rejections) for software applications included § 101 rejections before the *Alice* decision. This rate went up slightly to 9.73% after *Alice* was decided for applications filed before *Alice* and to 9.83% for applications filed after *Alice*.

Patent applications in the various sub-categories within software received *Alice* rejections and § 101 rejections to varying degrees. In the specific software art units, the unit that received the most *Alice* rejections was computer networks, in which 3.31% of all office actions for patent applications filed before *Alice* was decided, but examined after *Alice*, were *Alice* rejections. This rate increased to 5.66% for applications filed after the *Alice* decision. Eighteen percent of all office actions for applications in computer networks filed before *Alice* was decided, but examined after *Alice*, were § 101 rejections. This rate increased dramatically to 26.5% for applications filed post-*Alice*. In cryptography and security, 2.55% of office actions for applications filed before *Alice*, but examined after *Alice*, were *Alice* rejections, and this increased to 5.14% for applications filed post-*Alice*. Eighteen percent of all office actions for applications in cryptography and security filed before *Alice* was decided, but examined after *Alice*, were § 101

rejections, which then increased to 24.39% for patent applications filed after *Alice*.

Moreover, patent applications in computer networks, GUI and document processing, data bases and file management, cryptography and security, and computer graphics processing received a high percentage (about 8–10%) of final rejections under § 101 before *Alice* was decided. The rate increased to 19.32% post-*Alice* for applications in cryptography and security filed before *Alice* and increased to 22.53% for applications filed post-*Alice*. The rate increased to 18.18% after *Alice* was decided among applications in computer networks filed before *Alice* and increased to 23.28% for applications in computer graphics processing filed post-*Alice*. Compared to these increased percentages of rejections, patent applications in GUI and document processing, computer architecture, telecommunications, and recording and compression did not receive more final rejections under § 101 after *Alice*.

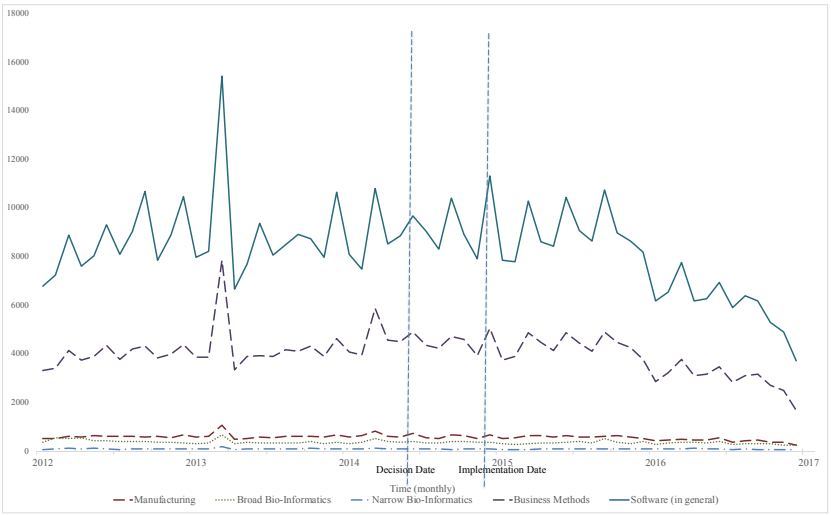


Figure 3. The Variation/Trend for Monthly Number of Patent Applications

In a broad view, the number of patent applications decreased in broad and narrow bioinformatics, business methods, and software in general, as shown in Figure 3 above. Before *Alice*, there were, on average, 392 patent applications filed per month in broad bioinformatics, within which ninety patent applications were in narrow bioinformatics. After *Alice*, there were about 339 patent applications filed per month in broad bioinformatics, and the patent applications filed in

narrow bioinformatics decreased to 81. Business methods-patent applicants filed 4,206 patent applications per month on average before *Alice* but filed 3,843 patent applications per month after *Alice*. Software-patent applicants, on average, filed 8,780 patent applications per month before *Alice* but filed 7,910 patent applications per month after *Alice*. The total patent applications also decreased by 10.64% after *Alice*. From 2012 to 2016, about 26% of the total patent applications were filed in software. About 12% were in business methods and about 1% were in broad bioinformatics.

Table 3. Means of Patent Applications per Month Between 2012 and 2016

| | Jan.2012-*Alice* | *Alice*-Dec.2016 | *Drop* | Jan.2012-*Alice* | Jan.2016-Dec.2016 | *Drop* |
|---|---|---|---|---|---|---|
| All Patent Applications | 33843.55 | 30241.35 | 10.64% | 33843.55 | 23837.83 | 29.56% |
| Broad Bioinformatics | 391.93 | 338.87 | 13.54% | 391.93 | 313.25 | 20.08% |
| % of All Patent Applications | 1.16% | 1.12% | | 1.16% | 1.31% | |
| Narrow Bioinformatics | 90.34 | 81.13 | 10.20% | 90.34 | 79.50 | 12.00% |
| % of All Patent Applications | 0.27% | 0.27% | | 0.27% | 0.33% | |
| Business Methods | 4206.00 | 3843.26 | 8.62% | 4206.00 | 2961.83 | 29.58% |
| % of All Patent Applications | 12.43% | 12.71% | | 12.43% | 12.42% | |
| Software (in general) | 8779.97 | 7910.36 | 9.90% | 8779.97 | 6014.00 | 31.50% |
| % of All Patent Applications | 25.94% | 26.16% | | 25.94% | 25.23% | |

Note: The data were collected from the Patent Examination Research Dataset (Public PAIR). https://www.uspto.gov/learning-and-resources/electronic-data-products/patent-examination-research-dataset-public-pair.

Table 3 reviews the decrease in patent application numbers before and after *Alice* by different time windows because the market and patent applicants needed time to react to *Alice* and adjust their patent strategies. Comparing the average number of patent applications filed per month one and a half years after *Alice* and one year after the *Alice* implementation by the PTO to the average number of patent applications filed per month before *Alice*, patent applications in broad and narrow bioinformatics, business methods, software in general, and the overall industry decreased at a higher level compared to the earlier comparisons. The total patent applications filed per month, on average, fell 29.56% after *Alice*. While the 20.08% decrease in patent applications in broad bioinformatics was lower than the drop in total

applications, the drops in business methods and software in general, at 29.58% and 31.5% respectively, were greater than the decrease in the total number of patent applications.

3. Methodology

*a. Logistic Regressions*

How were rejections under *Alice* given by patent examiners related to rejections under § 101 and to rejections under other statutory sections such as §§ 102, 103, and 112 in the initial and final decisions made by the PTO? In order to explore the association and the strength of the association between the *Alice* rejections and the statutory rejections, this study performs a regression analysis.

Even though the language of *Alice* does not directly address §§ 102, 103, or 112, these statutes are relevant to the patentability of an invention and are implicated by the *Alice* decision.[216] Therefore, the PTO rejections under all four statutes should be individually controlled in the regression analysis as independent variables. Since the presence or absence of each statutory category in an office action is binary (zero or one), this study first deploys logistic regressions and includes statutory rejections as independent variables to estimate whether a rejection under *Alice* was issued.

In logistic regressions, we observe the association between the presence of *Alice* rejections and any one of the four categories of statutory rejections (i.e., rejections based on §§ 101, 102, 103, or 112) as an initial or final rejection when taking all office actions regarding all four statutes into account. It is important for logistic models to control for month and for technology centers or art units as being fixed. We added fixed controls because all these factors could be direct or indirect reasons for strengthening the association between the *Alice* rejections and any one type of statutory rejection.[217]

*b. Difference-in-Difference Analyses*

We have observed a variation in § 101 rejections (which are either initial rejections or final rejections) among all office actions before and after the *Alice* decision.[218] Specifically, more initial and final rejections were given by examiners under § 101 and *Alice* for

216. *See supra* Part I.A.1.

217. Compared to logistic regressions, the chi-squared test per se used to test a correlation between variables in binary data cannot take those reasons into consideration.

218. *See supra* Part II.A.2.

applications in bioinformatics, business methods, and software after the *Alice* decision and its PTO implementation, regardless of whether patent applicants modified the disclosures and claims in their applications to better comply with the *Alice* decision.[219] In order to explore whether the *Alice* decision played a causal role in the increase in initial and final § 101 rejections, this study deploys the method of difference-in-difference (D-i-D) regressions. This method is used to observe if the intervention of the *Alice* decision made those three areas of technology receive more initial and final § 101 rejections compared to those technology areas that were not addressed by the *Alice* decision (e.g., manufacturing) but that used to receive § 101 rejections at a much lower level in their initial and final decisions given by the PTO. A parallel trends assumption needs to be tested under the D-i-D methodology: Before the *Alice* decision, was the variation in the proportion of § 101 rejections in office actions as a fraction of all office actions in the technology areas that were not impacted by the *Alice* decision parallel to the same variation for the three technology areas of interest? After the *Alice* decision, was this parallel trend maintained or was it disrupted?

The intervention of the *Alice* decision is considered under two dates. One date is the month (June 2014) when the opinion was delivered by the U.S. Supreme Court,[220] and the other date is the month (December 2014) when the PTO introduced the Interim Guidance implementing the *Alice* decision.[221] The two dates are separately deployed in the D-i-D regressions. The regression results between the two dates suggest a difference in how the opinion and implementation events affected patent applications and the office actions issued by patent examiners.

We selected the patent applications in manufacturing devices and processes, machine tools, and hand tools in art units 3722–3727 and in art unit 3729 as the control group. As the control group, we examine whether they are less likely to be affected by the *Alice* decision. Specifically, the control group of patent applications in manufacturing devices consistently received a very small number of § 101 rejections, which were at most 3.7% of all office actions per month and 0.06% of all office actions on average per month during the entire period from 2012 to 2016. We compared this control group with our study objects of patent applications in business methods, bioinformatics, and

219. *See supra* Part II.A.2.

220. Alice Corp. Pty. Ltd. v. CLS Bank Int'l, 134 S. Ct. 2347, 2347 (2014).

221. 2014 Interim Guidance on Patent Subject Matter Eligibility, 79 Fed. Reg. 74,618 (proposed Dec. 16, 2014) (to be codified at 37 C.F.R. pt. 1).

software. Patent applications in these three technology areas were then considered as independent treated groups.[222] All these treated groups received much more initial and final § 101 rejections between 2012 and 2016 than the control group and compared to other technology areas outside the scope of our data selection. Figure 4 below shows the specific monthly varying trends in the initial and final § 101 rejections for the control group of manufacturing and the treated groups of business methods, bioinformatics, and business methods. Not only did the four groups receive § 101 rejections in their initial and final PTO decisions at different levels, but the treated groups also received many more § 101 rejections in their initial and final decisions given by the PTO after *Alice* was decided.

Group difference is a binary variable, where zero represents the control group and one represents the treated group. Time difference is also a binary variable, which controls the time prior to the *Alice* decision as zero and the time post-*Alice* (decision or implementation) as one. In D-i-D regressions, the coefficient of the interaction term between group difference and time difference surrogates a D-i-D effect. In a model to estimate the probability of receiving a § 101 rejection in the office actions given by the PTO, a positive D-i-D effect or a positive coefficient for the D-i-D effect with statistical significance suggests that *Alice* induced a greater number of § 101 rejections for the treated group in their initial and final decisions given by the PTO.

222. In D-i-D analysis, a treated group or a treatment group refers to the samples that are expected to vary due to the treatment, such as a policy change.

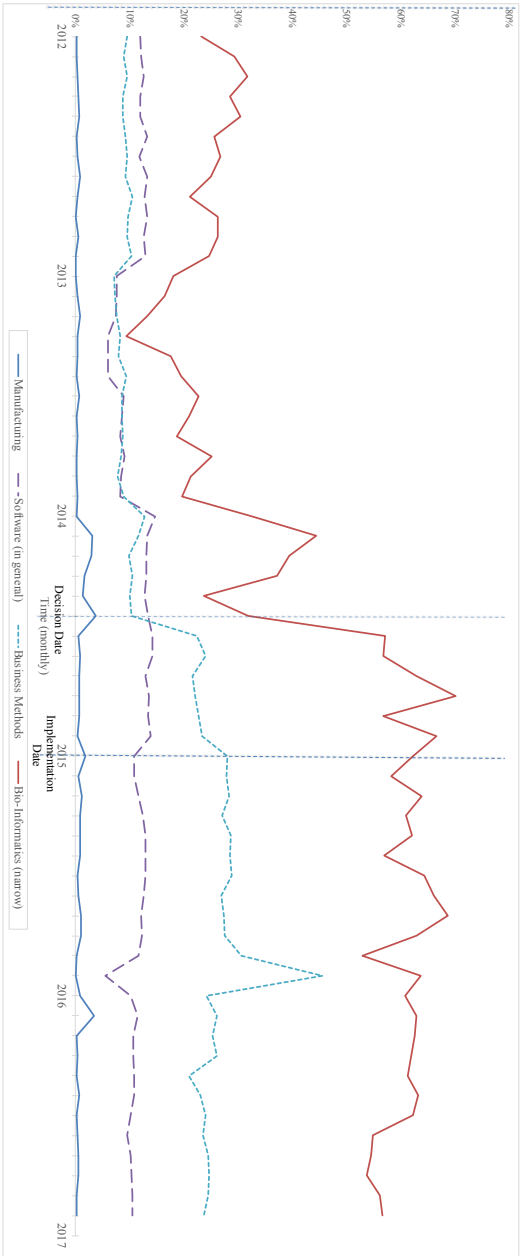


Figure 4. The Variation/Trend for Monthly § 101 Rejections as a Fraction of All Office Actions

This study splits the office actions given after the *Alice* decision into two groups. This coding strategy allows the study to observe how patent applicants attempted to modify the disclosures and claims in their patent applications to better comply with the *Alice* decision, a feature which was not taken into account by Chien and Wu.[223] In our strategy, one group refers to applications filed before the *Alice* decision but examined after *Alice*. In the models estimating the probability of receiving a § 101 rejection in an office action, the D-i-D effect of *Alice* with respect to these office actions shows how the examiners started taking into account the *Alice* decision. The other group refers to those patent applications filed after the *Alice* decision. The D-i-D effect with respect to the office actions in this latter group shows how applicants and their patent attorneys reacted to *Alice* in patent prosecution in addition to the reactions to *Alice* by examiners. After reviewing the *Alice* effect on all (initial and final) § 101 rejections, we separately reviewed the *Alice* effect on final office actions for patent applications that initially received § 101 rejections in the initial round of office actions in order to determine the ability of patentees to overcome those initially received § 101 rejections.

In order to explore the impact of *Alice* on patent applications with the D-i-D regressions, our identification assumption is that there are no reasons of law other than the *Alice* decision and the implementation of the *Alice* decision by the PTO that negatively affect the approval of patent applications in bioinformatics, business methods, and software. Moreover, before *Alice*, the variation in § 101 rejections for bioinformatics, business methods, and software should be parallel to the variation of § 101 rejections for mechanical manufacturing. This parallel trend should be broken by *Alice* and its implementation by the PTO.

### B. REGRESSION RESULTS

#### 1. Correlation Between *Alice* Rejections and Other Statutory Rejections

This study deploys logistic regressions to explore the correlations between the *Alice* office action rejections and the different statutory rejections. Section 101 rejections for all of the art units for bioinformatics, business methods, and software were positively correlated to *Alice* rejections at a statistically significant level. This statistical significance means that patent applications that were filed in

223. *See* Chien & Wu, *supra* note 39, at 14 (showing that the data and research cannot indicate how applicants adjusted their applications after *Alice*).

these three technology areas and received *Alice* rejections were more likely to be simultaneously rejected under § 101. After testing the data of patent applications that were filed in the three technology areas and received office actions after the PTO implementation of *Alice*, the degree of the correlation was similar to the correlation when deploying the data of patent applications that received office actions right after *Alice* was decided. In other words, the association between *Alice* rejections and § 101 rejections was not strengthened or weakened as *Alice* was implemented by the PTO or with the passage of time before 2016.

The art unit with the strongest association between *Alice* rejections and § 101 rejections among all technology areas was digital and optical communication.[224] Digital and optical communication was an art unit where patent applications that received an *Alice* rejection were most likely to be rejected under § 101 in initial and final decisions, compared to other art units that also received *Alice* rejections. Patent applications in computer graphics processing, data bases and file management, cryptography and security, computer networks, digital cameras, telemetry and code generation, software in general, bioinformatics, and business methods also had a very strong association between *Alice* rejections and § 101 rejections. Even though art units for specific categories in business methods for finance, e-commerce, health care, and cryptography also had a strong positive association between *Alice* rejections and § 101 rejections, the association was not as strong as the association in general business methods or other previously discussed art units for the specific categories in software.

The recording and compression art unit had the weakest positive association between *Alice* rejections and § 101 rejections. In other words, patent applications in recording and compression were the least likely to simultaneously receive more *Alice* rejections and more § 101 rejections in their initial or final decisions compared to other technology areas. Among all of the tested art units, the only art unit where all categories of statutory rejections were positively correlated to *Alice* rejections was data bases and file management. This means that patent applications in data bases and file management were always more likely to be rejected under *Alice* regardless of the type of statutory rejections that were issued.

In most of the other art units in the three technology areas, §§ 102, 103, or 112 rejections were either negatively correlated to *Alice* rejections or not correlated to *Alice* rejections at a statistically significant level. This suggests that patent applications in these art units

224. The specific logistic regression results are disclosed in Appendix B1 *infra*.

that received *Alice* rejections did not simultaneously receive other statutory rejections. Specially, in broadly defined bioinformatics, the frequency of receiving §§ 102, 103, and 112 rejections was negatively correlated to the frequency of receiving *Alice* rejections in the initial or final decisions. In other words, when patent applications in broadly defined bioinformatics received an increasing number of statutory rejections other than § 101 rejections, they were less likely to be rejected under *Alice*. By contrast, in bioinformatics, narrowly defined, § 102 rejections were not correlated to *Alice* rejections at a statistically significant level. In business methods, the frequency of receiving §§ 102 and 112 rejections was negatively correlated to *Alice* rejections, but § 103 rejections were positively correlated to *Alice* rejections. The negative correlation suggests that when patent applications in business methods received an increasing number of §§ 102 and 112 rejections, they were less likely to receive *Alice* rejections. When the applications received an increasing frequency of § 103 rejections, they were also more likely to receive *Alice* and § 101 rejections.

Table 4. Logistic Regressions to Predict Rejections Under *Alice*

Panel 1.

| Variables | bioinformatics | business methods | business methods of finance | business methods of e-commerce | software (in general) |
|---|---|---|---|---|---|
| § 101 | 6.000*** | 5.292*** | 4.591*** | 4.341*** | 5.143*** |
| | (0.581) | (0.0842) | (0.224) | (0.0896) | (0.0542) |
| § 102 | 0.148* | -0.148*** | -0.0843** | -0.145*** | -0.0217 |
| | (0.0822) | (0.0178) | (0.0412) | (0.0225) | (0.0245) |
| § 103 | -0.457*** | 0.0386** | 0.142*** | 0.0566** | -0.0669** |
| | (0.0680) | (0.0182) | (0.0356) | (0.0243) | (0.0277) |
| Obj. | 6,636 | 205,006 | 17,820 | 54,523 | 711,048 |
| $R^2$ | 0.284 | 0.476 | 0.163 | 0.192 | 0.473 |

| Panel 2. | data bases & file management | cryptography & security | telemetry & code generation | digital cameras | computer networks | digital & optical communication |
|---|---|---|---|---|---|---|
| § 101 | 7.181*** | 5.363*** | 5.341*** | 3.440*** | 5.218*** | 7.550*** |
| | (0.454) | (0.173) | (0.263) | (0.131) | (0.129) | (0.999) |
| § 102 | 0.0705 | -0.227*** | 0.0646 | -0.312*** | -0.0701 | -0.556* |
| | (0.0732) | (0.0610) | (0.142) | (0.110) | (0.0534) | (0.322) |
| § 103 | 0.338*** | 0.377*** | 0.316** | 0.523*** | -0.607*** | -0.265 |
| | (0.0908) | (0.0821) | (0.151) | (0.120) | (0.0585) | (0.256) |
| Obj. | 47,999 | 49,478 | 55,357 | 47,025 | 60,697 | 20,457 |
| $R^2$ | 0.473 | 0.438 | 0.462 | 0.382 | 0.429 | 0.500 |

Note: Month, art unit, and §112 are also controlled as fixed. *** p<0.01, ** p<0.05, * p<0.1.

Table 4 shows the correlations between § 101 rejections and other statutory rejections that were received in the initial or final decisions and are the independent variables deployed in the logistic regressions. Not only could these statutory rejections share an underlying rationale addressed in the *Alice* decision itself, but the covariations among the statutory rejections help us locate the true association between them and the *Alice* rejections. When the covariation or collinearity is high, different independent variables may represent the same statistical information and need not be independently explored.[225] Regarding § 112, this study specifically focuses on § 112(a) rejections (i.e., written description and enablement of specification[226]) and § 112(b) (i.e., definiteness of claims[227]) rejections. In our data of all of

225. *See* Rekha Molala, *MLmuse: Correlation and Collinearity—How They Can Make or Break a Model*, MEDIUM: CLAIRVOYANT (July 15, 2019), https://blog.clairvoyantsoft.com/correlation-and-collinearity-how-they-can-make-or-break-a-model-9135fbe6936a [https://perma.cc/TJ7C-NKG9].

226. *See* 35 U.S.C. § 112(a).

227. *See id.* § 112(b).

the PTO office actions between 2012 and 2016, examiners did not give any § 112(e) or (f)[228] rejections for any technology areas (not just for the studied technology areas listed in Table 1). Section 112 rejections were usually given under § 112(b).

In all tested technology areas listed in Table 1 other than manufacturing devices (the control group), the frequency of § 101 rejections was positively correlated with the frequencies of §§ 102, 103, and 112(b) rejections, regardless of whether the office actions were issued before or after *Alice*. In other words, a patent application that was rejected under § 101 was also likely to receive another §§ 102, 103, and 112(b) rejection. In bioinformatics, narrowly defined, the correlation between § 101 rejections and § 112(b) rejections was much stronger than the correlation between § 101 rejections and § 102 rejections. In other technology areas, the latter correlation was much stronger than the former correlation. Patent applications in narrowly defined bioinformatics that received a § 101 rejection were more likely to receive one more § 112(b) rejection than to receive one more § 102 rejection. By contrast, patent applications in other technology areas of broadly defined bioinformatics, business methods, or software that received a § 101 rejection were more likely to receive one more § 102 rejection as opposed to receiving one more § 112(b) rejection.

The correlation between § 101 rejections and § 112(a) rejections was weaker than the correlation between § 101 rejections and other statutory rejections (i.e., §§ 102, 103, and 112(b)), except for the office actions for business method patent applications after *Alice*. It means that even though patent applications that received a § 101 rejection were likely to receive one more § 112(a) rejection, this probability was lower than the probability of simultaneously receiving another statutory rejection other than § 112(a). Among the office actions issued after *Alice*, the correlation between § 101 and § 112(a) was stronger than (1) the correlation between § 101 rejections and § 102 rejections and (2) the correlation between § 101 rejections and § 112(b) rejections.

The correlation between § 101 rejections and § 112(a) rejections varied among technology areas. In some sub-categories of technology areas, including business methods of finance, AI, and computer architecture, there was no correlation between § 101 rejections and § 112(a) rejections at a statistically significant level among the office actions that were issued either before or after *Alice*. In these

228. *Id.* § 112(e)–(f).

technology areas, we did not find that a patent application rejected under § 101 was also likely to simultaneously receive a § 112(a) rejection. In narrowly defined bioinformatics, digital and optical communication, computer networks, digital cameras, and telemetry and code generation, there were positive associations between § 101 rejections and § 112(a) rejections at a statistically significant level among office actions issued after *Alice*. In data bases and file management and cryptography and security, there were positive associations between § 101 rejections and § 112(a) rejections at a statistically significant level among the office actions issued before *Alice*, which were much weaker compared to the association between § 101 rejections and other statutory rejections (e.g., rejections under §§ 101, 102, and 112(b)).

2. Difference-in-Difference Regression Results[229]

When comparing office actions issued before and after *Alice* for applications filed before the *Alice* decision in order to explore the causal effect of the *Alice* decision on examiners, the coefficients for the interaction term in the D-i-D regressions are positive and statistically significant in the models to estimate the probability of initially and finally receiving a § 101 rejection in business methods, bioinformatics, and the art unit for telemetry and code generation. While a parallel trend of receiving § 101 rejections between the control group, which refers to patent applications in manufacturing devices and processes, and the treated groups before *Alice* cannot be proven as shown in Figure 4 and Figure A1,[230] because of the fluctuations in § 101 rejections received by the treated groups, the difference in the level of receiving § 101 rejections between the control group and the treated groups are stable, suggesting a counterfactual trend to complement the parallel trend assumption.[231]

Due to an extremely low probability of initially and finally receiving § 101 rejections in the control group, the comparison of initially and finally receiving § 101 rejections between the treated groups and the control group may be simplified and understood as the likelihood of initially and finally rejecting applications in the treated group under

229. The robustness check for the D-i-D model design is included in Appendix D *infra*.

230. *See infra* Appendix A fig.A1.

231. *See generally* Ariella Kahn-Lang & Kevin Lang, *The Promise and Pitfalls of Differences-in-Differences: Reflections on* 16 and Pregnant *and Other Applications*, 38 J. BUS. & ECON. STAT. 613 (2020) (emphasizing that the nature of the parallel trend assumption is to show a counterfactual trend).

§ 101. Therefore, those positive coefficients suggest that *Alice* made patent applications in those technology areas more likely to be rejected under § 101 in the initial or final decisions. Meanwhile, the positive coefficients, interpreted as a positive D-i-D effect, surrogate negative effects of *Alice* on patent applications: patent applications were more likely to be rejected due to *Alice*.

The coefficients for the D-i-D effect of the implementation of *Alice* have a similar degree of statistical significance and similar value as the coefficients for the D-i-D effect of the *Alice* decision. The former coefficients are slightly stronger than the latter coefficients, which suggests that effects of the *Alice* decision and its implementation on patent examiners were consistent, and the PTO implementation of the *Alice* decision had a slightly larger effect on examiners than the *Alice* decision itself.

The coefficients for the D-i-D effect of the *Alice* decision are positive and statistically significant in the models that estimate the probability of issuing § 101 rejections for bioinformatics, some art units for the sub-categories in business methods, and two art units with respect to software (e.g., computer networks and telemetry and code-generation telemetry). The positive coefficients suggest that the *Alice* decision caused patent applications filed post-*Alice* in these technology areas to be more likely to be rejected under § 101. Similar to the regressions with respect to applications filed before the *Alice* decision, but examined post-*Alice*, the coefficients for the D-i-D effect of the PTO implementation of *Alice* have a similar degree of statistical significance and value as the coefficients for the D-i-D effect of the *Alice* decision. This similarity suggests that *Alice's* effect was consistent as to its impact on examiners reviewing applications filed post-*Alice*. We now turn to the effects of *Alice* on patent examiners issuing office actions in each technology area and how *Alice* increased the likelihood of receiving § 101 rejections.

*a. Bioinformatics*

This Subsection first explores art units 1631 and 1639 with respect to bioinformatics, narrowly defined. Among all types of technologies listed in Table 1, narrowly defined bioinformatics has the highest positive coefficient for the interaction term between the date that *Alice* was decided and the two groups of office actions, one group including the office actions given before the *Alice* decision and the other group including the office actions issued after the *Alice* decision, but only for applications filed before *Alice*. The probability of initially and finally rejecting patent applications in narrowly defined

bioinformatics filed before *Alice* under § 101 increased 83% after the *Alice* decision. It increased slightly to 84.3% after the *Alice* decision was implemented by the PTO. In other words, the *Alice* decision made patent applications in narrowly defined bioinformatics filed before *Alice* but examined after *Alice* about four times more likely to receive a § 101 rejection than not to receive a § 101 rejection. This likelihood decreased to two times when we employed the data of art unit 1630 for broadly defined bioinformatics.

Table 5. D-i-D Logit Regressions on § 101 Rejections for (Narrow) Bioinformatics

The models shown below are logistic regressions. The dependent variable is the § 101 rejection. It is binary, so a rejection refers 1 and an allowance refers 0. In the independent variables, *Alice* is a categorical variable controlling for the time period before and after the *Alice* decision or the time period before the *Alice* decision and after the implementation of the *Alice* decision by the USTPO. Technology is a categorical variable controlling for the control group and the treated group. Time refers to the decision date or implementation date of *Alice*. The coefficient on the interaction term surrogates the D-i-D effect. Whether the office action also gives a § 102, § 103, or § 112 rejection is independently controlled as fixed in the model. Time (month) is controlled as fixed in the model. Technology center is controlled as fixed in model 1, 3, 5, to 8. James Stock's Heteroskedasticity-standard errors are shown in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

| | All Rejections | | | |
|---|---|---|---|---|
| Panel 1 | Applications Filed Aefore the *Alice* Decision | | Applications Filed After the *Alice* Decision | |
| | Decision Date | Implementation Date | Decision Date | Implementation Date |
| VARIABLES | (1) | (2) | (3) | (4) |
| Time | 0.0140 | -0.0614 | 0.565* | 0.560* |
| | (0.255) | (0.258) | (0.303) | (0.304) |
| Technology | -10.73*** | 4.185*** | 4.198*** | 4.196*** |
| | (2.122) | (0.0934) | (0.0941) | (0.0941) |
| Time × Technology | 1.593*** | 1.681*** | 1.352*** | 1.359*** |
| | (0.126) | (0.130) | (0.185) | (0.186) |
| Constant | 8.806*** | -6.129*** | -6.345*** | -6.344*** |
| | (2.089) | (0.187) | (0.190) | (0.190) |
| Observations | 75,667 | 71,577 | 46,593 | 46,509 |
| Pseudo R-squared | 0.569 | 0.570 | 0.473 | 0.472 |
| | Final Rejections | | | |
| Panel 2 | Applications Filed Before the *Alice* Decision | | Applications Filed After the *Alice* Decision | |
| | Decision | Implementation | Decision | Implementation |
| VARIABLES | (5) | (6) | (7) | (8) |
| Time | -1.010 | -1.404* | -0.443 | -0.443 |
| | (0.814) | (0.835) | (1.308) | (1.308) |
| Technology | -15.45*** | -14.77*** | 1.724*** | 1.724*** |
| | (1.169) | (1.209) | (0.503) | (0.503) |
| Time × Technology | 2.581*** | 3.013*** | 2.593** | 2.593** |
| | (0.612) | (0.643) | (1.031) | (1.031) |
| Constant | 13.90*** | 13.18*** | -3.148*** | -3.148*** |
| | (1.231) | (1.284) | (0.742) | (0.742) |
| Observations | 2,383 | 2,301 | 705 | 705 |
| Pseudo R-squared | 0.355 | 0.356 | 0.327 | 0.327 |

Table 5 introduces the D-i-D model design and shows the results of the D-i-D regressions for narrowly defined bioinformatics.[232] The coefficient for the D-i-D effect for patent applications filed after *Alice* is slightly smaller than the coefficient with respect to the patent applications filed before *Alice* but examined post-*Alice*. The specific coefficients suggest that the probability of patent applications filed after the *Alice* decision receiving an initial or final § 101 rejection increased 79% after the *Alice* decision, which is about 16% lower than the increased probability of § 101 rejections for applications filed before *Alice* but examined after *Alice*. In other words, while the *Alice* decision resulted in the probability of initially and finally rejecting applications filed before *Alice* but examined after *Alice* under § 101 to be about four times higher than the probability of allowing patent applications under § 101, the former probability decreased to a lower degree among applications filed and examined after *Alice*.

The likelihood of receiving a final rejection under § 101 in narrowly defined bioinformatics increased after *Alice*. The degree of the increase was similar to the increase after the PTO implementation of the *Alice* decision. The percentage of patent applications receiving a final rejection under § 101 increased one to two times after *Alice*. The percentage rejected under § 101 in bioinformatics, narrowly defined, was higher than for patent applications in business methods and other art units related to software. Before the *Alice* decision, 31.22% of the final office actions in narrowly defined bioinformatics were § 101 rejections. After the *Alice* decision, 75.12% of the final office actions (i.e., rejection or allowance) for applications in narrowly defined bioinformatics filed before *Alice* but examined after *Alice* were § 101 rejections and 68.15% of final office actions for applications filed after *Alice* were § 101 rejections. By contrast, the percentage of § 101 rejections for patent applications in broadly defined bioinformatics was reduced by half after *Alice*.

If patent applicants did not withdraw their applications after they received a § 101 rejection, they either received another § 101 rejection as a final rejection or overcame the initially received § 101 rejection so that their applications were finally allowed or rejected for reasons other than § 101. The percentage of final rejections under § 101 for patent applications in narrowly defined bioinformatics increased one to two times after the *Alice* decision. Moreover, the degree of its increase is similar to the degree of increase after the PTO implementation of *Alice*.

232. The specific model design is discussed in Appendix C *infra*.

Among narrowly defined bioinformatics patent applications that were filed before the *Alice* decision, examined after *Alice*, and rejected once under § 101, *Alice* caused the probability of them receiving a § 101 rejection in their final decision to be increased by about 93%. In other words, the *Alice* decision made those applications about twelve times more likely to fail in overcoming their initial § 101 rejections compared to successfully overcoming their initial § 101 rejections. Narrowly defined bioinformatics patent applications filed and examined after *Alice* and applications filed before *Alice* but examined after *Alice* faced a similar challenge in overcoming an initial § 101 rejection. *Alice* made these applications about twelve times more likely to fail in overcoming the initial § 101 rejections. Moreover, the coefficient for the interaction term in the model with the PTO implementation date as the event date is larger than the coefficient in the model deploying the *Alice* decision date. This suggests that the PTO implementation of the *Alice* decision made the applications filed before *Alice* nineteen times more likely to fail in overcoming their initial § 101 rejections received from the examiners.

By contrast, the *Alice* decision did not have a statistically significant effect on how applications in broadly defined bioinformatics overcame their initial § 101 rejections. However, the PTO implementation of *Alice* had a negative, statistically significant effect on how the broadly defined bioinformatics patent applications filed before *Alice* and examined after *Alice* overcame their initial § 101 rejections. The implementation of *Alice* caused patent applications in broadly defined bioinformatics to be three times more likely to fail in overcoming their initial § 101 rejections—a smaller effect than the negative effect of the *Alice* implementation on applications in narrowly defined bioinformatics.

*b. Business Methods*

The D-i-D models for patent applications in business methods have a high positive coefficient for the D-i-D effect of the *Alice* decision. In other words, the *Alice* decision had a negative effect on patent applications in business methods. The probability of business method applications filed before *Alice*, but examined after *Alice*, that received an initial or final § 101 rejection increased 82% because of *Alice*. That percentage increased slightly to 83.79% after we applied the interaction term with the implementation date of the *Alice* decision by the PTO. Similar to patent applications in narrowly defined bioinformatics, the *Alice* decision caused patent applications in business methods filed before *Alice* but examined after *Alice* to be about four times more

likely to receive an initial or final § 101 rejection. However, the coefficient for the D-i-D effect of the *Alice* decision was negative and statistically significant in the models with respect to business method applications filed after the *Alice* decision. This coefficient suggests that *Alice* did not induce an increase in initial and final § 101 rejections for business method applications filed after *Alice*. These applications, which were filed and examined after *Alice*, were still 55% more likely to receive an initial or final § 101 rejection compared to business method patent applications filed and examined before *Alice*. That number decreased to 30% when we applied the interaction term with the implementation date of the *Alice* decision by the PTO.

Table 6. D-i-D Logit Regressions on § 101 Rejections for Business Methods
The models shown below are logistic regressions. The dependent variable is the § 101 rejection. It is binary, so a rejection refers 1 and an allowance refers 0. In the independent variables, *Alice* is a categorical variable controlling for the time period before and after the *Alice* decision or the time period before the *Alice* decision and after the implementation of the *Alice* by the USTPO. Technology is a categorical variable controlling for the control group and the treated group. The coefficient on the interaction term surrogates the D-i-D effect. Whether the office action also gives a § 102, § 103, or § 112 rejection is independently controlled as fixed in the model. Time (month) and technology center are controlled as fixed in the model. James Stock's Heteroskedasticity-standard errors are shown in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

| | All Rejections | | | |
|---|---|---|---|---|
| Panel 1 | Applications Filed Before the *Alice* Decision | | Applications Filed After the *Alice* Decision | |
| | Decision | Implementation | Decision | Implementation |
| VARIABLES | (1) | (2) | (3) | (4) |
| Time | 0.584*** | 0.464*** | 0.595*** | 0.571*** |
| | (0.125) | (0.130) | (0.161) | (0.163) |
| Technology | 3.095*** | 3.094*** | 3.110*** | 3.110*** |
| | (0.0876) | (0.0876) | (0.0875) | (0.0875) |
| Time × Technology | 1.518*** | 1.643*** | -0.383** | -0.359** |
| | (0.117) | (0.122) | (0.154) | (0.156) |
| Constant | -6.172*** | -6.189*** | -6.258*** | -6.265*** |
| | (0.0937) | (0.0938) | (0.0940) | (0.0940) |
| Observations | 550,136 | 504,181 | 380,488 | 379,363 |
| Pseudo R-squared | 0.181 | 0.191 | 0.0799 | 0.0795 |
| | Final Rejections | | | |
| Panel 2 | Applications Filed Before the *Alice* Decision | | Applications Filed After the *Alice* Decision | |
| | Decision | Implementation | Decision | Implementation |
| VARIABLES | (5) | (6) | (7) | (8) |
| Time | -0.289 | -0.678 | 0.181 | 0.181 |
| | (1.746) | (1.746) | (1.806) | (1.806) |
| Technology | 0.936** | 0.938** | 0.928** | 0.928** |
| | (0.433) | (0.433) | (0.431) | (0.431) |
| Time × Technology | 2.700*** | 3.093*** | 1.231* | 1.231* |
| | (0.524) | (0.538) | (0.641) | (0.641) |
| Constant | -3.204* | -3.215* | -3.168* | -3.169* |
| | (1.720) | (1.715) | (1.737) | (1.738) |
| Observations | 43,217 | 41,223 | 13,174 | 13,157 |
| Pseudo R-squared | 0.292 | 0.293 | 0.199 | 0.199 |

Table 6 introduces the D-i-D model design and shows the results of the D-i-D regressions for business methods. The likelihood of receiving a final rejection under § 101 increased one to two times because of the *Alice* decision. Before *Alice*, 25.59% of final office actions for business method patent applications were § 101 rejections. After *Alice*, 74.26% of the final office actions for applications filed before the *Alice* decision were § 101 rejections, and 49.62% of final office actions for applications filed after *Alice* were § 101 rejections.

Moreover, *Alice* affected the probability of failing to overcome the initially received § 101 rejections for business method patent applications to increase by about 94%. In other words, *Alice* made business method applications filed before *Alice* about fourteen times more likely to fail in overcoming their initial § 101 rejections received from patent examiners. The coefficient for the interaction between the PTO implementation date and the technology types is larger than the coefficient for the interaction between the *Alice* decision date and the technology types. This difference suggests that the PTO implementation of *Alice* had a stronger effect on patent applicants' failure to overcome their initial § 101 rejections. Specifically, the PTO implementation made business method patent applications filed before the *Alice* decision but examined after *Alice* about twenty-one times more likely to fail in overcoming their initial § 101 rejections. Although patent applications filed after *Alice* were also less likely to overcome their initial § 101 rejections, those applications were less likely to fail in overcoming their initial § 101 rejections compared to the applications filed before *Alice* and examined after *Alice*. The *Alice* decision made the applications filed after *Alice* about two times more likely to fail in overcoming their initial § 101 rejections.

In studying the three sub-categories in business methods, we found that their coefficients for the D-i-D effect are much higher compared to narrowly defined bioinformatics or business methods in general. Moreover, the effects of the *Alice* decision on applications filed before *Alice* but examined after *Alice* were similar to the effects on applications filed and examined after *Alice*. Among the business methods in finance, the probability of issuing § 101 rejections to applications filed before *Alice* increased 98% because of the *Alice* decision. The *Alice* decision made applications of business methods in finance about fifty-one times more likely to receive a § 101 rejection. The probability of issuing § 101 rejections to the applications in the business methods of finance filed before *Alice* increased 97% due to the *Alice* decision. The *Alice* decision increased this likelihood of receiving an initial or final § 101 rejection by a factor of twenty-eight, but this effect of *Alice*

was weaker than its effect on applications filed before the *Alice* decision. For patent applications filed before the *Alice* decision, the *Alice* decision caused those patent applications to be about fifty-four times more likely to fail in overcoming the initial § 101 rejections. Moreover, the PTO implementation of *Alice* made it 107 times more likely that a patent application would fail to overcome its initial § 101 rejection.

Among e-commerce applications filed before *Alice*, the probability of receiving a § 101 rejection in an initial or final decision increased 95% for the *Alice* decision. This suggests that the *Alice* decision caused these applications to be about twenty times more likely to receive a § 101 rejection compared to not receiving rejections under § 101 in their initial and final decisions (i.e., receiving an allowance or an initial or final rejection under §§ 102, 103, or 112). Similar to applications of e-commerce filed before the *Alice* decision but examined after *Alice*, the probability of receiving a § 101 rejection in an initial or final decision also increased by about 95% because of the *Alice* decision among e-commerce applications filed after *Alice*. The e-commerce patent applications filed after *Alice* also had a higher probability of failing in overcoming the initial § 101 rejections than average business method applications. The *Alice* decision made e-commerce applications filed before the *Alice* decision but examined after *Alice* about twenty-one times more likely to fail in overcoming their initial § 101 rejections. Furthermore, the PTO implementation of the *Alice* decision increased this likelihood to thirty-eight times more than the likelihood of successfully overcoming the initial § 101 rejections. Additionally, the *Alice* decision made e-commerce applications filed after *Alice* about thirteen times more likely to fail in overcoming their initial § 101 rejections; this is smaller than the likelihood of the § 101 rejections as a final rejection received by those applications in the business methods in e-commerce filed before the *Alice* decision.

Within e-commerce, this study looked at two specific art units: art unit 3626 with respect to health care and art unit 3621 with respect to cryptography. The models for these two art units have relatively higher coefficients for the D-i-D effect compared to general business methods. The D-i-D regression results suggest that the two art units were affected by the *Alice* decision to a slightly higher degree than the effect of *Alice* on general business methods.

For business methods in health care, the probability of patent applications filed before the *Alice* decision that received an initial or final § 101 rejection increased 97% because of the *Alice* decision. This suggests that the *Alice* decision made the health care applications about thirty-two times more likely to receive an initial or final § 101

rejection compared to not receiving a § 101 rejection in the initial or final PTO decisions. The probability of applications filed and examined after the *Alice* decision that received an initial or final § 101 rejection increased about 97% because of the *Alice* decision, suggesting that the *Alice* decision made health care applications about thirty-five times more likely to receive an initial or final § 101 rejection. Moreover, the *Alice* decision made health care applications filed before the *Alice* decision about thirty-two times more likely to fail in overcoming their initial § 101 rejections, which is higher than the likelihood of failing to overcome the initial § 101 rejections in general business methods. While the PTO implementation of *Alice* had a stronger negative effect on the likelihood that an application would overcome its initial § 101 rejection, the likelihood of failing to overcome their initial § 101 rejections among the health care applications filed and examined after *Alice* was slightly lower than the applications filed before *Alice* but examined after *Alice*. Specifically, the *Alice* decision made the health care applications filed and examined after *Alice* twenty-nine times more likely to fail in overcoming their initial § 101 rejections.

In business methods of cryptography, the probability of applications filed before *Alice* receiving an initial or final § 101 rejection increased 95% because of the *Alice* decision. This suggests that *Alice* made these applications about seventeen times more likely to receive an initial or final § 101 rejection as compared to not receiving a § 101 rejection in their initial and final decisions from the PTO (e.g., receiving an allowance or an initial or final rejection under §§ 102, 103, or 112). Moreover, the probability of applications in business methods of cryptography filed after the *Alice* decision receiving a § 101 rejection increased 95% because of the *Alice* decision. This suggests that the *Alice* decision made these applications about eighteen times more likely to receive an initial or final § 101 rejection as compared to not receiving an initial or final rejection under § 101 (e.g., receiving an allowance or an initial or final rejection under §§ 102, 103, or 112). The *Alice* decision also made the applications in business methods of cryptography filed after the *Alice* decision forty-two times more likely to fail in overcoming their initial § 101 rejections.

Compared to other art units in business methods, the PTO implementation of *Alice* had a relatively weaker negative effect on overcoming the initial § 101 rejections among cryptography applications. The PTO implementation made applications in business methods of cryptography filed before the *Alice* decision thirty-five times more likely to fail in overcoming their initial § 101 rejections. The *Alice* decision had an even weaker negative effect on the applications filed after the *Alice*

decision to overcome their initial § 101 rejections. The likelihood of failing to overcome the initially received § 101 rejections decreased from thirty-five times among the cryptography applications that were filed before *Alice* to nineteen times among the cryptography applications that were filed after *Alice*.

*c. Software Art Units*

For software in general (e.g., TC 2100, TC 2400, and TC 2600), we did not find statistically significant results from the D-i-D regressions, as shown in Appendix C1.[233] It suggests that we cannot conclude that *Alice* had a causal effect on receiving § 101 rejections among software patent applications in general. We reviewed twelve specific software art units, listed in Table 1 above, and found that some art units show statistically significant results in the D-i-D regressions.

When deploying the *Alice* decision date as the event date, the coefficients for the D-i-D effect of the *Alice* decision are positive and statistically significant in the models for art units 2688 and 2686 with respect to sub-categories in software of telemetry and code generation. The values of the coefficient are much lower than the coefficients in bioinformatics and business methods. In those specific two art units in software, the probability of applications filed before the *Alice* decision but examined after *Alice* receiving an initial or final § 101 rejection increased around 63% (with respect to art unit 2688) and 68% (with respect to art unit 2686) because of the *Alice* decision. In other words, the *Alice* decision caused the applications in these two art units filed before *Alice* to be twice as likely to receive an initial or final § 101 rejection; this is much lower than the likelihood of receiving an initial or final § 101 rejection from the PTO in bioinformatics and business methods.

In art unit 2686 with respect to telemetry and code generation, applications filed after the *Alice* decision were more likely to receive an initial or final § 101 rejection as compared to applications filed before the *Alice* decision. The probability of applications receiving a § 101 rejection in their initial or final decisions increased 70% because of the *Alice* decision, about 4% higher than the increased probability of receiving initial or final § 101 rejections among applications filed before the *Alice* decision. However, the coefficient for the D-i-D effect or the parameter of the *Alice* decision was negative, even though the D-i-D parameter is positive for applications filed before the *Alice* decision and suggests a positive effect for the *Alice* decision on these

233. *See infra* Appendix C Table C1.

applications. In other words, among patent applications in art unit 2686, the possibility that applications filed and examined after *Alice* would receive an initial or final § 101 rejection is slightly lower compared to that same possibility for applications filed before the *Alice* decision but examined after *Alice*.

Moreover, the implementation of *Alice* had a stronger effect on applications in computer networks filed before and examined after the *Alice* decision at a statistically significant level. Note that applications in computer networks were not more likely to be rejected under § 101 in their initial and final decisions from the PTO after the *Alice* decision. In other words, patent applications in computer networks became more likely to be initially or finally rejected under § 101 after the PTO implementation of the *Alice* decision. However, this increased likelihood is very small—about 0.28 times more likely to be initially or finally rejected under § 101 than not receiving a § 101 rejection in their initial and final decisions from the PTO (e.g., receiving an allowance or an initial or final rejection under §§ 102, 103, or 112). On the other hand, patent applications in computer networks filed after the *Alice* decision were more likely to receive an initial or final § 101 rejection compared to applications filed before the *Alice* decision but examined after *Alice*. The probability of applications filed after the *Alice* decision receiving an initial or final § 101 rejection increased 61% because of the *Alice* decision; this is about 6% higher than the increased probability of receiving initial or final § 101 rejections for applications filed before the *Alice* decision.

As a robustness check, we also studied the D-i-D effect only with the data after January 2013 because software in general had a sharp decrease in the percentage receiving § 101 rejections over all office actions received in January 2013. We cannot explain the sharp decrease in 2013, which was also ignored in the discussion of *Alice*'s effect on software patent applications by other scholars or professionals.[234] It could be a lagged effect of the America Invents Act (AIA)[235] or *Mayo*,[236] or it used to be high all along, perhaps after the *Bilski* decision in 2010,[237] and the 2013 data were only an aberration.

234. *See, e.g.*, Christopher P. King, *#ALICESTORM: August 2018 Update*, BILSKI BLOG (Aug. 13, 2018), https://www.bilskiblog.com/2018/08/alicestorm-august-2018-update [https://perma.cc/A9FG-KJ3D].

235. Sections 102, 103, and 112 were amended under the AIA, and these amendments were gradually implemented between September 16, 2011 and March 16, 2013. *See* U.S. PAT. & TRADEMARK OFF., AMERICA INVENTS ACT: EFFECTIVE DATES (2011); U.S. PAT. & TRADEMARK OFF., *supra* note 99, § 2159.01–04.

236. Mayo Collaborative Servs. v. Prometheus Lab'ys, Inc., 566 U.S. 66 (2012).

237. Bilski v. Kappos, 561 U.S. 593 (2010).

After the adjustment of the time period before the *Alice* decision, software in general also did not have a statistically significant D-i-D effect of the *Alice* decision. Specifically, TC 2100 with respect to computer architecture and TC 2600 with respect to communications did not show a statistically significant D-i-D effect of the *Alice* decision. However, some art units for sub-categories in software, including computer networks, data bases and file management, and cryptography and security, showed small positive and statistically significant coefficients for the D-i-D effect of the *Alice* decision. The coefficients suggest that the applications filed in those three areas were more likely than not to receive an initial or final § 101 rejection after the *Alice* decision.

The percentage of applications receiving a final rejection under § 101 increased after *Alice* at different levels in all tested sub-categories in software, excluding GUI and document processing. The degree of the increase was close to the increase after the PTO implementation of *Alice*. There was a minor increase in three technology areas, including computer architecture, data bases and file management, and recording and compression.

Figure 5 below presents the coefficients of the interaction term in the D-i-D regressions for the sub-categories of software technologies to estimate the probability of receiving final rejections under § 101.[238] Error bars in Figure 5 refer to the standard error of the regressions results, representing the variability of the data. Long error bars indicate that a coefficient is not statistically significant, so its value or direction is not sufficiently reliable to explain the relationship in the regression.

As suggested by final rejections, applications in cryptography and security were negatively affected by the *Alice* decision in overcoming their initial § 101 rejections at a statistically significant level. This effect was smaller than the effect on applications in the business methods of cryptography. In other words, patent applications in the business methods of cryptography faced greater difficulty in overcoming their initial § 101 rejections than patent applications in the software of cryptography and security. Moreover, even though applications in the software of cryptography and security were more likely to receive initial and final § 101 rejections than not to be rejected under § 101 (i.e., receiving an allowance or an initial or final rejection under §§ 102, 103, or 112) before the *Alice* decision, this likelihood did not

238. Specific coefficients in the D-i-D regression results are reported in Appendix Tables C1 and C2 *infra*.

reach a statistically significant degree after the *Alice* decision. The *Alice* decision made applications in the software of cryptography and security filed before *Alice* about two times more likely to fail in overcoming their initial § 101 rejections, and this increased to three times under the effect of the PTO implementation of *Alice*. Patent applications in the software of cryptography and security filed after the *Alice* decision were not influenced by either the *Alice* decision or its implementation at a statistically significant level.

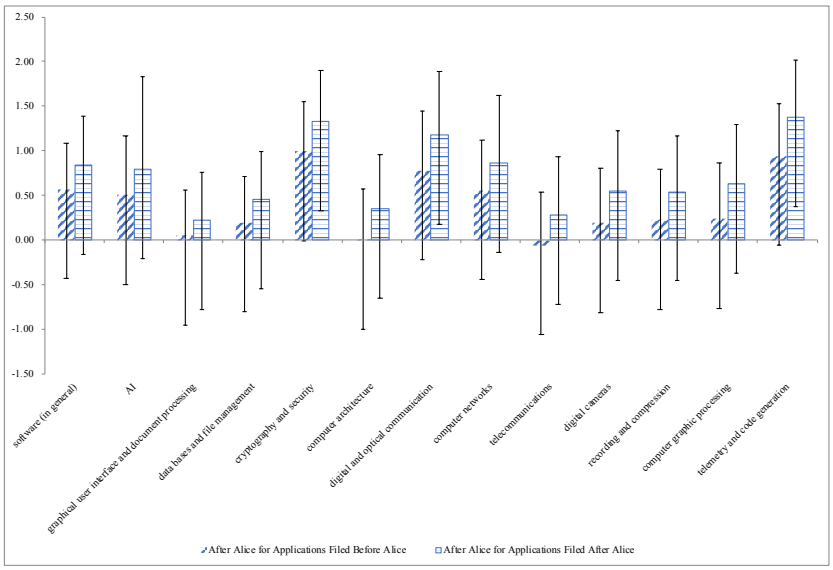


Figure 5. Coefficients of the Interaction Between *Alice* Decision and Technology to Estimate Final § 101 Rejections with Error Bars in the Logit D-i-D Regressions

By contrast, the implementation of the *Alice* decision made digital and optical communication applications filed before *Alice* two times more likely to fail in overcoming their initial § 101 rejections, while the *Alice* decision did not have a statistically significant effect on how applications in digital and optical communication overcame the initial § 101 rejections. Similarly, in telemetry and code generation, even though applications filed before the *Alice* decision but examined after *Alice* did not experience more difficulty in overcoming the initial § 101 rejections at a statistically significant level due to the *Alice* decision, the PTO implementation of *Alice* made those applications three times more likely to fail in overcoming their initial § 101 rejections. Furthermore, the *Alice* decision made telemetry and code generation

applications filed after the *Alice* decision five times more likely to fail in overcoming their initial § 101 rejections, a statistically significant level. Besides the applications in the above three sub-categories in software (i.e., cryptography and security, digital and optical communication, and telemetry and code generation), the D-i-D regression results in Part II for other sub-categories in software listed in Table 1 do not show any statistically significant effects of the *Alice* decision or its implementation on applications either filed before the *Alice* decision but examined after *Alice* or filed after the decision. In other words, our empirical evidence does not suggest that *Alice* increased the barrier of patentability for those technology areas in software.

## III. IMPLICATIONS

This Part addresses the implications of our empirical analysis. Increased uncertainties, including uncertainties in patent application allowances and responding to patent office action rejections, impose additional costs on patent applicants during patent prosecution.[239] When patent applicants cannot successfully overcome these rejections, the costs are transformed into expenses in accounting terms.[240] The increased costs or expenses are a direct result of the uncertainties and increased transaction costs.[241] This Part presents an efficiency analysis based on the empirical results and then analyzes whether the design of the Revised Guidance[242] can improve efficiency when implementing *Alice*.

### A. INCREASED § 101 REJECTIONS BY USPTO PATENT EXAMINERS

This section discusses the discrete § 101 rejections issued by patent examiners in various technology areas that were affected by *Alice*. Patent applications in bioinformatics received the most initial or final § 101 rejections compared to business methods and software. *Alice* caused the increased initial or final § 101 rejections for business methods, but it is not clear whether it was a reason for the increased initial or final § 101 rejections for many sub-categories in software.

239. *See supra* note 82 and accompanying text.

240. *See supra* note 82 and accompanying text.

241. *See supra* note 82 and accompanying text.

242. 2019 Revised Patent Subject Matter Eligibility Guidance, 84 Fed. Reg. 50 (Jan. 7, 2019).

1. Bioinformatics

Bioinformatics, narrowly defined, had been the area most likely to be initially and finally rejected under § 101 compared to other technology areas before *Alice*. After *Alice*, about two-thirds of all office actions for applicants in bioinformatics were initial or final § 101 rejections. The proportion of final § 101 rejections in final office actions for bioinformatics also became larger after *Alice*. Our finding regarding narrowly defined bioinformatics is consistent with the observation by Gaudry and Hayim, who only tracked the rejections and allowance for bioinformatics in art units 1631, which is narrower than our data selection.[243] The time period for their data is longer than ours—it covers office actions between 2013 and 2019.[244] Their data show that bioinformatics in art units 1631 suffered an increase of § 101 rejections since *Alice*, but they are optimistic regarding patent applications in bioinformatics because their data suggest that since 2018, the allowance rate of patent applications in art unit 1631 increased back to the degree before *Alice*.[245] However, a reversal to the previous allowance rates does not remove the problems created by *Alice*.

The *Alice* decision is the reason for the increased § 101 rejections issued to narrowly defined bioinformatics applications in their initial or final examination rounds, and that is proven by the D-i-D regression results in Part II.[246] The increased initial and final § 101 rejections due to *Alice* suggest increased uncertainties in patent eligibility.[247] Applicants in narrowly defined bioinformatics need to spend money and time to overcome the rejections that they received from the PTO in the initial round of patent examination. Moreover, the PTO implementation of the *Alice* decision strengthened this effect of the *Alice* decision further and resulted in a larger likelihood of initially and finally receiving § 101 rejections for applications in narrowly defined bioinformatics. In other words, the PTO further increased the application and/or prosecution costs in narrowly defined bioinformatics when implementing the *Alice* decision. Compared to bioinformatics, narrowly defined, *Alice* and its implementation had a smaller effect on the technologies within the scope of broadly defined bioinformatics in art

243. Kate Gaudry & Samuel Hayim, *Bioinformatics Innovations Thrive Despite 101 Chaos*, IPWATCHDOG (Feb. 6, 2019), https://www.ipwatchdog.com/2019/02/06/bioinformatics-innovations-thrive-despite-101-chaos [https://perma.cc/7EJW-QLAY].

244. *Id.*

245. *Id.*

246. *See supra* Part II.

247. *See supra* Part I.B.

unit 1630. Thus, within art unit 1630, art units 1631 and 1639 bore the consequences of the *Alice* decision and its implementation by the PTO the most.

2. Business Methods

In business methods, the data suggest that the *Alice* decision clearly caused an increase in patent application rejections. Patent applications in business methods received both more § 101 rejections and more *Alice* rejections in their initial and final decisions from the PTO because of the *Alice* decision. In other words, *Alice* induced an increase in uncertainties related to patent eligibility in business methods. The increased uncertainties and increased probability of receiving initial or final rejections under § 101 and *Alice* increased prosecution costs when patent applicants tried to overcome those rejections.[248] However, for applicants who addressed their initially received § 101 rejections or *Alice* rejections when responding to patent examiners, an increased proportion of them failed to overcome the § 101 rejections or *Alice* rejections. According to the D-i-D regression results in Part II, the *Alice* effect that patent applications of business methods received more initial or final § 101 rejections due to *Alice* was strengthened when the PTO publicly decided to implement its decision.[249] This finding is consistent with what Chien and Wu observed with PTO office actions during a period of time that is longer than ours.[250] Even though Chien and Wu did not observe how *Alice* instructed applicants to adjust their applications,[251] our research design allows us to prove that patentees were successful in overcoming *Alice*-based rejections for applications filed after the *Alice* decision, but not for applications filed before the *Alice* decision.[252]

When general business methods in TC 3600 received more initial or final § 101 rejections based on the *Alice* decision and its implementation, the effects of *Alice* on the sub-categories in the technology areas within business methods in TC 3600 were different. Specifically, business methods in finance and business methods in the e-commerce of health care or cryptography faced stronger *Alice* effects than

248. *See supra* note 82 and accompanying text.

249. *See* 2014 Interim Guidance on Patent Subject Matter Eligibility, 79 Fed. Reg. 74,618 (proposed Dec. 16, 2014) (to be codified at 37 C.F.R. pt. 1).

250. *See* Chien & Wu, *supra* note 39, at 1 (applying the data of office actions taken between 2008 and mid-July 2017).

251. *Id.* at 14.

252. Empirical results are presented in Tables 5 and 6 and discussed in Part III.B.1 *infra*.

business methods in general. *Alice* caused patent applications in these technology areas to be more likely to be rejected by the PTO under § 101 in their initial or final decisions compared to patent applications in all of business methods.

3. Software Art Units

Patent applications for software in general were not heavily rejected under § 101 in their initial or final decisions received from the PTO before *Alice* as compared to bioinformatics and business methods, wherein patent applicants received a far greater percentage of rejections under *Alice* or the PTO's implementation of *Alice*. The proportion of office actions in software with initial and final § 101 rejections did not increase much after the *Alice* decision or its implementation by the PTO. D-i-D regression results in Part II do not show that either the *Alice* decision or the PTO's implementation of *Alice* increased the initial and final § 101 rejections for patent applications for software in general. We find that the rejection rate under § 101 for software patent applications was relatively consistent (around 12%) in the period between 2012 and 2016, except for a small, inexplicable drop in the § 101 rejection rate during 2013 (to around 8%). The § 101 rejection rate for software inventions, however, was much higher than the rejection rate for mechanical inventions in the control group (below 1%). This suggests that the increase in § 101 rejections for software inventions may have occurred at a time prior to the *Alice* decision, perhaps as a result of the *Bilski v. Kappos* decision in 2010[253] or some other developments prior to 2012. This point may be explored further in future empirical work.

In some sub-categories of software, such as the art units for computer networks and GUI, an increased proportion of the applications were initially or finally rejected under § 101 after the *Alice* decision. In addition to the increased initial and final § 101 rejections, some software art units also received increasingly more *Alice* rejections in their initial and final decisions from the PTO. Uncertainties in patent eligibility increased after *Alice*, and the applicants in those areas spent more time and money on overcoming § 101 rejections after *Alice*.[254]

The two technology areas that bore the greatest increase in costs are computer networks (art units 2440 and 2450) and cryptography and security (art units 2430 and 2490). Not only did they receive more initial § 101 rejections after the *Alice* decision, but they also received

253. 561 U.S. 593 (2010).

254. *See supra* Part I.B.

an increase of final rejections under § 101 after the *Alice* decision. This suggests that applicants faced difficulties in overcoming their initial § 101 rejections.

This superficial overview of the § 101 rejections and *Alice* rejections, however, does not necessarily mean that the *Alice* decision caused the increase in the rejections, even though their *Alice* rejections were correlated to their § 101 rejections. On the one hand, the D-i-D regression results can only prove that the *Alice* decision directly resulted in an increase in initial and final § 101 rejections for applications in telemetry and code generation (only art units 2686 and 2688). On the other hand, based on the D-i-D regression results, we cannot conclude that the *Alice* decision had a direct effect on the initial and final rejections in the area of computer networks. We do find, however, that the PTO's implementation of the *Alice* decision directly resulted in more initial and final § 101 rejections for patent applications in computer networks. In other words, regardless of the direct effect of the *Alice* decision from the Supreme Court, the PTO's implementation of *Alice* increased the application and/or prosecution costs for applications directed at computer networks.[255]

In addition to the increased costs of patent prosecution for software inventions that received an increasing number of § 101 rejections and *Alice* rejections in their initial and final decisions received from the PTO, the software industry may have limited access to capital from investors as a result of these eligibility rejections. In David Taylor's survey of 475 venture capitalists and private equity investors between 2009 and 2017, he found that investors in general consider patent eligibility when making investment decisions.[256] Even though the inability to obtain patent protection may not directly drive them to reduce investment in software and Internet inventions,[257] once investors are aware of cases such as *Alice*,[258] *Myriad*,[259] and *Bilski*[260] that address patent eligibility issues, they become overwhelmingly

255. *See supra* note 82 and accompanying text.

256. David O. Taylor, *Patent Eligibility and Investment*, 41 CARDOZO L. REV. 2019, 2027 (2019) ("[O]verall, 74% of the investors agreed that patent eligibility is an important consideration in firm decisions whether to invest in companies developing technology . . . .").

257. *See id.* at 2028 ("Investors overwhelmingly indicated, for example, that the elimination of patents would either not impact their firm's' decisions whether to invest in companies or only slightly decrease investments in companies developing technology in the . . . software and Internet (80%) . . . industr[y].").

258. Alice Corp. Pty. Ltd. v. CLS Bank Int'l, 134 S. Ct. 2347 (2014).

259. Ass'n for Molecular Pathology v. Myriad Genetics, Inc., 569 U.S. 576 (2013).

260. Bilski v. Kappos, 561 U.S. 593 (2010).

negative about investing in the industries of software, the Internet, and biotechnology.[261] In other words, Taylor's finding that the uncertainties in patent eligibility harm investment and innovation in the software industry[262] is supported by our general empirical evidence showing higher rejections rates for applications directed at software inventions.

### B. THE ABILITY OF PATENT APPLICANTS TO OVERCOME § 101 REJECTIONS

In this section, we focus on discussing the effect of *Alice* on the industries of bioinformatics and business methods. The applicants in these two industries faced greater uncertainties in patent eligibility and as a result bore more costs or expenses in patent prosecution due to *Alice*.[263] This could be an inevitable result of *Alice* seeking to prevent people from patenting something that raises an issue of preemption and thereby to benefit the public interest.[264] Alternatively, it could merely show that the increased transaction costs, resulting from the uncertainties created by *Alice*,[265] harm investment incentives and innovation incentives in those technology areas.

#### 1. Difficulties in Overcoming § 101 Rejections in Bioinformatics

This empirical study finds two indicators that suggest an increase in the difficulty of overcoming initial § 101 rejections in bioinformatics, both narrowly and broadly defined. First, applicants filed fewer patent applications in bioinformatics, narrowly and broadly defined, after the *Alice* decision. Second, an increasing number of these patent applications were finally rejected under § 101 after the *Alice* decision. Within those applications directed at the narrowly defined bioinformatics sector that were finally rejected under § 101, a larger proportion of the applications had also received initial § 101 rejections.

Patent applicants in bioinformatics, narrowly and broadly defined, became pessimistic about filing more patent applications after *Alice*. The average number of patent applications filed in bioinformatics, narrowly defined, decreased by 74.21% per month during the

261. *See* Taylor, *supra* note 256, at 2082–83 (showing that 63% of eligibility knowledgeable investors reported negative impacts within the software and Internet industry and 86% of eligibility knowledgeable investors reported negative impacts within the biotechnology industry).

262. *See id*. at 2083–85 (suggesting a negative impact of the Supreme Court's decisions on innovative companies' value).

263. *See supra* note 82 and accompanying text.

264. *See* Alice Corp. Pty. Ltd. V. CLS Bank Int'l, 134 S. Ct. 2347, 2360 (2014).

265. *See supra* Part I.A.1.c.

nineteen months after the *Alice* decision (June 2014 to December 2015) compared to the same length of time before the *Alice* decision (January 2013 to May 2014).[266] The median number of patent application filings per month was 144 before the *Alice* decision. This number decreased to thirty-one after the *Alice* decision.[267] The sharpest decrease occurred in June 2014, when the *Alice* decision was delivered by the Supreme Court. Applications filed in June 2014 were 48.56% lower than the average patent applications in bioinformatics, narrowly defined, filed in the nineteen months before the *Alice* decision and continued to decrease over time. In January 2015, the first month after the PTO implemented the *Alice* decision, this number further decreased by 63.07% as compared to before the *Alice* decision. The applicants in narrowly defined bioinformatics made cautious adjustments by modifying the disclosures and claims after the *Alice* decision, and applicants in broadly defined bioinformatics did the same. The patent applicants in broadly defined bioinformatics also filed fewer patent applications after *Alice*. The number of applications filed per month on average decreased by 51.06% after the *Alice* decision. The median for the number of patent applications was 638 before the *Alice* decision, and this number decreased to 307 after *Alice*.

From the examiners' perspective, *Alice* caused examiners to be more likely initially and finally to reject applications filed after *Alice* under § 101, even though applicants filed increasingly fewer patent applications for narrowly defined bioinformatics. In other words, for those decreased applications self-selected by the applicants, the *Alice* decision also added some expenses for these applicants. Our data also show that the decreased number of applications in narrowly defined bioinformatics were nevertheless more likely to be finally rejected by examiners under § 101. Examiners gave increasingly more final rejections to patent applications in narrowly defined bioinformatics under § 101. For patent applications that had initially received a § 101 rejection, the D-i-D model design in this study shows a causal effect of the *Alice* decision; specifically, applicants in narrowly defined bioinformatics were less likely to overcome their initial § 101 rejections and more likely to receive a final rejection under § 101.

Moreover, applications in narrowly defined bioinformatics filed after the *Alice* decision had greater difficulty in overcoming their

266. The average initial action pendency in technology center 1600 is 12.1 months, so our data derived from Reed Tech may reduce the filing numbers which are in the nineteen months after the *Alice* decision for both narrow bioinformatics and broad bioinformatics. The specific statistics are disclosed in Appendix Table A1 *infra*.

267. RCE is counted among independent filings.

initially received § 101 rejections compared to applications filed before the *Alice* decision. In the D-i-D regression results shown in Table 5, the coefficient in the model for applications filed after the *Alice* decision is larger than the coefficient in the model for applications filed before the *Alice* decision. Accordingly, applicants in narrowly defined bioinformatics were not clearly instructed by the Supreme Court in its *Alice* decision, even though they reacted to the law and adjusted their patent preparation and filing strategies. The adjusted filing strategies or modified disclosures and claims failed to work, and applicants merely spent more money on patent applications that would not be approved. What is worse is that *Alice* may have not only added more application or prosecution costs in the business of bioinformatics, but the case may have also restricted applicants' access to investors and capital through the market.

Bioscience, which is broader than bioinformatics, however, faces various layers of uncertainties, such as the uncertainties in research, in finding an application of the research to human health, and in patent applications. Patents incentivize scientists and firms to engage in bioscience R&D despite these uncertainties.[268] Even though innovation in bioscience may harm or benefit mankind, the Supreme Court has noted that it does not mean to deter or disincentivize innovation in bioscience, especially genetic research, by requiring a narrow scope of patentable subject matter in bioscience.[269] The utility bar excludes some bioscience research from patentability if the application of the research is uncertain, regardless of the efforts made to obtain those research findings.[270]

When the utility requirement cannot be satisfied due to uncertainties in the research results, inventors may attempt to bring more specificity or clarity by engaging in further R&D. However, when the *Alice* decision induced more § 101 rejections, the previous utility rejections under § 101 were expanded to include rejections for ineligible subject matter, also under § 101, further compounding the uncertainty in prosecution outcomes and increasing the overall cost of patent prosecution. As David Taylor's survey regarding investors shows, not receiving patent protection directly results in lesser investment in biotechnology by venture capitalists and private equity investors.[271]

268. *See* Rebecca S. Eisenberg, *Analyze This: A Law and Economics Agenda for the Patent System*, 53 VAND. L. REV. 2083, 2090 (2000).

269. Diamond v. Chakrabarty, 447 U.S. 303, 316–18 (1980).

270. Brenner v. Manson, 383 U.S. 519, 530 (1966).

271. *See* Taylor, *supra* note 256, at 9 ("[I]nvestors . . . overwhelmingly indicated that the elimination of patents would either somewhat decrease or strongly decrease

There is a continuing concern that the *Alice* decision obfuscates the distinction between eligibility under § 101 and non-obviousness under § 103 by focusing on what is generally known in the art. This concern is also addressed in the text of the proposed eligibility legislation introduced in the House.[272] Nevertheless, we find that the association between § 101 rejections and §§ 102, 103, or 112(b) rejections decreased after *Alice* among patent applications in narrowly defined bioinformatics (e.g., art units 1631 and 1639). By contrast, the association between § 101 rejections and § 112(a) rejections for patent applications in narrowly defined bioinformatics increased after *Alice*. That strengthened association may suggest that overcoming the problems of written description and enablement may help with overcoming § 101 eligibility rejections in bioinformatics.

2. Diverse Reactions in Business Methods and Software

Patent applicants filed fewer patent applications in business methods after *Alice*. In TC 3600 for general business methods, the number of patent application filings per month on average decreased by 38.16% in the twelve months after the *Alice* decision (June 2014–June 2015) compared to the same length of time before the *Alice* decision (May 2013–May 2014).[273] The median for the patent filing numbers per month was 9,018 before the *Alice* decision, and it decreased to 5,445 after the *Alice* decision. The degree of the decrease was higher for patent applications in the business methods of finance and e-commerce. In finance, the average number of patent application filings per month decreased by 57.63% in the thirteen months after the *Alice* decision. In e-commerce, the average number of patent application filings per month decreased by 79.11% after the *Alice* decision. Within e-commerce, after the *Alice* decision, the average number of patent application filings in cryptography per month decreased by 67.41%, and the average number of patent application filings in health care per month decreased by 86.41%.

In contrast to the immediate and sharp decrease in the number of patent applications in bioinformatics after the *Alice* decision, patent

their firm's investments in the biotechnology (77%).").

272. *See* Restoring America's Leadership in Innovation Act, H.R. 6264, 115th Cong. § 7 (2018) (drafting as "[t]he eligibility of a claimed invention under subsections (a) and (b) shall be determined without regard as to the requirements or conditions of sections 102, 103, and 112 of this title, or the claimed invention's inventive concept").

273. The average initial action pendency in technology center 1600 is 18.2 months, so our data derived from Reed Tech may deduce the filing numbers in the thirteen months after the *Alice* decision for business methods and the art units within business methods.

applications in business methods started decreasing in July 2014, one month after the *Alice* decision. The average number of patent applications decreased 24.03% in July 2014, compared to the thirteen months before the *Alice* decision. The decrease in patent applications for business methods was incremental, and a sharp decrease occurred when the PTO decided to implement the *Alice* decision.[274] In January 2015, the first month after *Alice* was implemented by the PTO, this number further decreased by 48.33% compared to before the *Alice* decision. Patent applications in the business methods of health care, which is the art unit that decreased the most in the sub-categories in business methods after the *Alice* decision, decreased to twenty-seven, compared to 237, the median number for patent applications in the thirteen-month period before the *Alice* decision.

Overall, this study finds that patent applicants in business methods were gradually adjusting their application strategies: applicants filed fewer applications after the *Alice* decision, especially those in health care business methods. In addition to applicants' reaction to the law, they also filed far fewer patent applications after the implementation of the law by the PTO. The high degree of the decrease after the *Alice* decision and its implementation by the PTO may also show that the applicants are pessimistic about the allowance prospects for their patent applications. However, the decrease in patent allowance does not necessarily mean that *Alice* impedes innovation in business methods. While a narrower scope of patent eligibility may not incentivize innovation in particular technologies, it does not necessarily deter innovation in those technology areas.[275] Innovative companies practicing business methods in those areas may use trade secrets, rather than patents, if they are barred from receiving patent protection.[276]

Moreover, the patent applications in business methods filed after the *Alice* decision were not more likely to be initially or finally rejected by patent examiners under § 101, as suggested by the negative estimator of the interaction term in the D-i-D regressions in Table 6.[277] The ability to adjust to the *Alice* decision is most clearly seen in the business methods of cryptography, wherein *Alice* did not increase

274. 2014 Interim Guidance on Patent Subject Matter Eligibility, 79 Fed. Reg. 76,418 (proposed Dec. 16, 2014) (to be codified in 37 C.F.R. pt. 1).

275. Diamond v. Chakrabarty, 447 U.S. 303, 317 (1980).

276. *Id.*

277. *See supra* Table 6. Due to the limitation of the time period for the data, we do not have the data for many final decisions on patent applications filed after *Alice*. In our discussion in this Subsection, we do not separate initial and final decisions.

initial and final § 101 rejections for the applications filed after *Alice* compared to applications filed before *Alice*. By contrast, the patent applications filed after *Alice* in finance or e-commerce were more likely to be initially or finally rejected under § 101 compared to patent applications filed before the *Alice* decision. Thus, *Alice* imposed costs on both examiners and applicants in the fields of business methods in health care, finance, and e-commerce.

Examiners gave more final rejections to applications in business methods under § 101 after the *Alice* decision. In other words, after the *Alice* decision, applicants faced difficulties in successfully overcoming § 101 rejections. For applications that initially received a §101 rejection, *Alice* made it more difficult for them to overcome their initial § 101 rejections. The implementation of the law by the PTO increased the uncertainties in patent eligibility and the difficulties in overcoming these uncertainties to a higher degree.

*Alice* also increased the prosecution costs for patent applications in business methods, which could be absorbed by applicants when they modified their disclosures and claims to render them less likely to be finally rejected under § 101 (i.e., receive an allowance or a final rejection under §§ 102, 103, or 112). However, for those applicants who failed to modify successfully their disclosures and claims in their patent applications and overcome these § 101 rejections, *Alice* increased overall patent prosecution costs. In the business methods of finance and e-commerce, applicants were not clearly guided by the *Alice* decision, and they did not successfully adjust their patenting strategies, despite filing fewer patent applications. These applicants faced higher patent prosecution expenses because of *Alice* and the PTO's implementation of it. The increase in the expenses for patent applications in the business methods of finance was higher than the increase in the expenses for patent applications in the business methods of e-commerce.

The goal of the Supreme Court in *Alice* was to exclude those claims that constitute the "building blocks of human ingenuity," which create risks of preemption.[278] Therefore, increased rejections under § 101 after *Alice* might serve as evidence showing that the risk of preemption created by patents has also been reduced by patent examiners. Additional evidence concerning this risk of preemption is the increased association between the frequency of receiving § 101 and § 112(a) rejections in both initial and final office actions from the PTO after *Alice*.

278. Alice Corp. Pty. Ltd. v. CLS Bank Int'l, 134 S. Ct. 2347, 2355 (2014).

An alternative explanation for the increased § 101 rejections in the three sub-categories in business methods is that the law is not clear enough to instruct examiners and patent applicants and merely creates costly uncertainties. This study observed that the association between § 101 and § 103 rejections among the patent applications in business methods was heavily strengthened after *Alice*. This result is the clearest support for the widespread criticism that the teachings in *Alice* that focus on what is "generally known" both necessarily and incorrectly draw the prior art into the eligibility inquiry. The relation between §§ 101 and 103 for business method patent applications is the opposite of what we have seen earlier in bioinformatics.

We cannot prove that *Alice* caused more § 101 rejections in general software and most sub-categories of software technologies.[279] However, we observe that the *Alice* decision resulted in fewer § 101 rejections in some software technologies (e.g., databases and file management, cryptography and security, GUI and document processing, and computer architecture). In these four technology areas, the association between § 101 rejections and § 112(a) rejections was weakened after *Alice*. In contrast, the association between § 101 and § 102 or § 103 rejections was strengthened after *Alice* for software applications in these technology areas.

### C. THE FUTURE OF SHIFTING TRANSACTION COSTS TO THE PTO

This Section discusses how the 2019 Revised Guidance from the PTO tries to mitigate the increased costs of patent prosecution faced by patentees. The D-i-D empirical results in Part II show the effect of the *Alice* decision and its implementation by the PTO on examiners and patent applicants.[280] In some technology areas, such as bioinformatics, business methods, and software of telemetry and code generation, we find that the *Alice* decision induced more initial and final § 101 rejections issued by patent examiners to applications, especially for applications filed before the *Alice* decision. The direction of the effect of the PTO implementation is consistent with the *Alice* decision, but the PTO's implementation had a stronger effect than *Alice* itself. After the PTO published its specific Interim Guidance to implement the *Alice* decision, applicants received more § 101 rejections in the initial round of patent examination, and it became more difficult to overcome these rejections. Therefore, the PTO implementation of *Alice* further increased the cost of patent prosecution for patentees.

279. The implementation of *Alice* by the PTO caused more § 101 rejections for patent applications in computer networks. *See supra* Part III.A.1.

280. *See supra* Part II.B.2.

In January 2019, the PTO issued Revised Patent Subject Matter Eligibility Guidance.[281] The PTO added more detailed instruction in this Revised Guidance in order to decrease the uncertainty of patenting and the transaction costs created by *Alice* and its implementation.[282] Besides the additional Step 2A and Step 2B, compared to the Interim Guidance, there is one more step added after the two-prong test for carefully exploring the eligibility of patent applications.[283]

The PTO double-checks before rejecting a patent application under § 101 based on *Alice* or *Mayo*.[284] If a patent claim involves an "abstract idea," and it does not have an additional element or combination of additional elements that provide an inventive concept, it is rejected in Step 2B. However, this does not mean that the PTO rejects that claim under § 101 based on *Alice* or *Mayo*. The Revised Guidance requires that if the rejected abstract idea fits into the enumerated categories of abstract ideas, examiners should bring such an application to the attention of the Technology Center Director.[285]

The Revised Guidance enumerates three types of abstract ideas in accordance with several precedents from the Supreme Court or the Federal Circuit.[286] The three types of abstract ideas are mathematical concepts,[287] certain methods of organizing human activity,[288] and mental processes.[289] Any rejections for reciting an "abstract idea" that is not enumerated in the Revised Guidance must be approved by the Technology Center Director and must provide justification for why such claim limitation(s) are treated as reciting an abstract idea.[290]

281. 2019 Revised Patent Subject Matter Eligibility Guidance, 84 Fed. Reg. 50 (Jan. 7, 2019).

282. *See supra* Part I.B.3.

283. 2019 Revised Patent Subject Matter Eligibility Guidance, 84 Fed. Reg. at 57.

284. Alice Corp. Pty. Ltd. v. CLS Bank Int'l, 134 S. Ct. 2347, 2355 (2014); Mayo Collaborative Servs. v. Prometheus Lab'ys, Inc., 566 U.S. 66 (2012).

285. 2019 Revised Patent Subject Matter Eligibility Guidance, 84 Fed. Reg. at 50, 52, 57.

286. *Id.* at 52.

287. Mathematical concepts include mathematical relationships, mathematical formulas or equations, and mathematical calculations. *Id.*

288. The methods include fundamental economic principles or practices (including hedging, insurance, and mitigating risk); commercial or legal interactions (including agreements in the form of contracts; legal obligations; advertising, marketing or sales activities or behaviors; and business relations); managing personal behavior, relationships, or interactions between people (including social activities, teaching, and following rules or instructions). *Id.*

289. Mental processes include concepts performed in the human mind (including an observation, evaluation, judgment, or opinion). *Id.*

290. *Id.* at 57.

Both the additional procedure and the additional indication about reciting "abstract ideas" in the justification add transaction costs to the PTO. Four years after the PTO formally implemented the *Alice* decision under the Interim Guidance, the PTO put forth further efforts to clarify the boundary between "abstract ideas" and non-abstract, patent-eligible subject matter.[291] This additional analysis results in an increase in administrative transaction costs at the PTO.[292]

This increase could be a result of shifting the increased transaction costs in the market that are borne by patent applicants and investors to the PTO. For example, our empirical results in Part II show that both the *Alice* decision and its implementation by the PTO increase patent prosecution costs or expenses on applicants in some technology areas, such as bioinformatics, business methods of e-commerce, business methods of finance, and software of cryptography and security. Even though applicants adjusted their application strategies, modified the disclosures and claims in their applications, and spent more money on patenting because of the changes in the law, there was still significant difficulty in overcoming § 101 rejections. The Revised Guidance suggests that the PTO decided to take on the burden to clarify the law through the revised Step 2 and the added second review procedures pertaining to the elements that are not listed in the Revised Guidance.[293]

The efficiency with which the Revised Guidance reduces the uncertainties regarding patent eligibility could be limited by the PTO itself. In other words, it is hard to predict whether transaction costs will be successfully shifted from the market to the PTO or whether it ends up increasing the costs borne by both the market and the PTO. First, the Interim Guidance, which had provided a more detailed test than the *Alice* test itself, increased the transaction costs in the market, as shown in our empirical results.[294] PTO economists Andrew Toole and Nicholas Pairolero analyzed patent applications in the technology centers affected by *Alice*.[295] While they showed that patent applications

291. *Id.*

292. 2014 Interim Guidance on Patent Subject Matter Eligibility, 79 Fed. Reg. 76,418 (proposed Dec. 16, 2014) (to be codified in 37 C.F.R. pt. 1).

293. 2019 Revised Patent Subject Matter Eligibility Guidance, 84 Fed. Reg. at 52. It does not suggest that the Revised Guidance is binding on the federal courts.

294. 2014 Interim Guidance on Patent Subject Matter Eligibility, 79 Fed. Reg. 76,418.

295. ANDREW A. TOOLE & NICHOLAS A. PAIROLERO, OFF. OF THE CHIEF ECONOMIST, U.S. PAT. & TRADEMARK OFF., ADJUSTING TO *ALICE*: USPTO PATENT EXAMINATION OUTCOMES AFTER *ALICE CORP. V. CLS BANK INT'L* 1 (2020), https://www.uspto.gov/sites/default/files/documents/OCE-DH_AdjustingtoAlice.pdf [https://perma.cc/F8JT-2NKK].

filed before and examined after the implementation of the Revised Guidance were less likely to receive a first office action with a § 101 rejection compared to those filed and examined before the implementation of the Revised Guidance, the probability of receiving a first office action with a § 101 rejection after the implementation of the Revised Guidance decreased less than before the *Alice* decision.[296] Toole and Pairolero also showed that patent examiners serving the TCs affected by *Alice* were less likely to issue a first office action with § 101 rejections after the implementation of the Revised Guidance.[297] However, once again, the probability of those examiners issuing a § 101 rejection decreased to a lower degree than before the *Alice* decision.[298] In addition, the two pairs of comparisons do not consider the variation in the total number of patent applications filed before and after *Alice*.[299] Thus, these results may confirm the PTO's efforts to decrease the uncertainties in patent eligibility,[300] but they cannot estimate both the transaction costs borne by applicants who may have adjusted their application behaviors after *Alice* and the impact on innovation through applicants foregoing all patent protection for their inventions. Second, the Revised Guidance may not affect how the courts determine patent eligibility or how they apply *Alice*[301] because the judicial system is also a critical player in continuously creating uncertainties in patent eligibility.[302] It is hard, however, to predict how the PTO's justification addressing the uncertainties of patentability will be perceived on review by the judicial system.[303]

296. *See id.* at 3, 5.

297. *Id.*

298. *See id.* at 4, 6.

299. *Id.* at 1.

300. *See generally id.*

301. *See, e.g.*, *In re* Smith, 815 F.3d 816, 819 (Fed. Cir. 2016); *see also* Steven Swan, *Plugging the Rabbit Hole: The Supreme Court's Decision in* Alice, 2016 UTAH L. REV. 891, 898 (arguing that the PTO internal memo is not binding in federal court and "cannot serve as a proper basis for appeals or petitions of review").

302. *See generally* Gugliuzza & Lemley, *supra* note 36, at 783. *But see* Jasper L. Tran & J. Sean Benevento, Alice *at Five*, 2019 PATENTLY-O PAT. L.J. 25, 25 (noting a decrease in the "*Alice* invalidation rate at the Federal Circuit and district courts" in the past five years).

303. When determining the patentability of new technology in the Federal Circuit, Judge Moore relied on the PTO's evaluation, but Judge Bryson did not give credit to the PTO in his dissent. Judge Bryson said that "the PTO lacks substantive rulemaking authority as to issues such as patentability." Ass'n for Molecular Pathology v. Myriad Genetics, Inc., 569 U.S. 576, 587–89 (2013). *But see* Raymond Millien, *Six Years After* Alice*: 61.8% of U.S. Patents Issued in 2019 Were 'Software-Related'—Up 21.6% from 2018*, IP-WATCHDOG (Feb. 17, 2020), https://www.ipwatchdog.com/2020/02/17/six-years-alice-61-8-u-s-patents-issued-2019-software-related-21-6-2018 [https://

The PTAB provides a mechanism by which we can examine the possible efficiencies gained at the PTO through the judicial system. The Federal Circuit reviews the PTO's tests regarding patent eligibility as applied in PGRs or CBMs at the PTAB that employ the Revised Guidance.[304] Therefore, not only will the enumerated specific types of abstract ideas be presented to the Federal Circuit, but other new types of abstract ideas outside the scope of patent protection dynamically added by the TC directors will also be reviewed by the Federal Circuit.

After the Revised Guidance for § 101 came out in 2019, the PTO revised the Guidance for § 112 because a claim drafted broadly is not an issue under § 101 (i.e., patentable subject matter or utility), but it is an issue under § 112 (i.e., written description or enablement).[305] This could be more important in some particular software technologies, such as databases and file management, cryptography and security, computer architecture, GUI and document, and computer graphics processing. The data analyzed in this study show that the association between § 101 rejections and § 112(a) rejections in those technology areas decreased after *Alice*. *Alice* and the Revised Guidance for § 101 may not be sufficient to deal with the preemption problem in those technology areas.

We also find that when an applicant in bioinformatics, business methods, or software received a § 101 rejection, they were very likely to simultaneously receive a § 112(b) rejection. This may suggest that if an applicant can overcome a § 101 rejection, it also effectively helps to overcome § 112 rejections. In general, the positive association between § 101 rejections and § 112(a) or (b) rejections increased after *Alice* in bioinformatics, business methods, and software of digital and optical communication, computer networks, telecommunications, digital cameras, recording and compression, telemetry and code generation, and software. Therefore, in those areas, the preemption issue was better addressed by the PTO after *Alice*, notwithstanding the increased costs imposed on applicants.

perma.cc/4Q7W-KT57] (showing that the USTPO issued 21.6% more of software-related patents in 2019 compared to 2018).

304. *See* Jay P. Kesan & Carol M. Hayes, *Patent Eligible Subject Matter After* Alice, *in* RESEARCH HANDBOOK ON ELECTRONIC COMMERCE LAW 235, 253 (John A. Rothchild ed., 2016) (applying the example of *Versata* to show that the Federal Circuit reviews patentable subject matter issues raised at the PTAB); Versata Dev. Grp., Inc. v. SAP Am., Inc., 793 F.3d 1306 (Fed. Cir. 2015); *see also* Gugliuzza & Lemley, *supra* note 36, at 794 (finding that the Federal Circuit merely defers to the PTAB on *Alice* issues).

305. Interview by Grantland Drutchas with Andrei Iancu, Under Sec'y of Com. for Intell. Prop. and Dir. of U.S. Pat. & Trademark Off., at Chi.-Kent Coll. of L. (Feb. 19, 2019).

## CONCLUSION

We studied the nature and extent of the uncertainties caused by *Alice's* two-part test at the PTO, focusing on three technology areas—software, bioinformatics and business methods. Our causal empirical study of the *Alice* decision reveals how that case impacted both patent examiners and patent applicants, increasing the transaction costs associated with patent prosecution and creating uncertain outcomes in patent allowance. Patent applicants employed different strategies (e.g., filing amended patent claims, filing new patent applications, or choosing to abandon or never pursue patent protection) to attempt to comply with *Alice*.

Patent applicants in all three technology areas decreased their reliance on the patent system and filed fewer patent applications as compared to the time period before *Alice*, with the greatest reduction occurring in bioinformatics. Patentees in some technology areas (e.g., business methods in general) were successful in overcoming § 101 rejections after *Alice*, but patentees in other areas (e.g., bioinformatics and finance or e-commerce business methods) were not as successful in overcoming *Alice*-based rejections. Applications in bioinformatics received many more § 101 rejections based on *Alice*, but these applicants also faced difficulties in overcoming those rejections. Meanwhile, patent applications based on business methods also received more § 101 rejections based on *Alice*. But patent applicants in business methods learned from *Alice* and received fewer § 101 rejections when they filed patent applications after *Alice*. *Alice* also imposed various degrees of patenting costs for different types of software innovation.

In addition to the PTO, other patent institutions, such as the Federal Circuit, have struggled to operationalize *Alice* and thereby mitigate its uncertain application. Indeed, the Federal Circuit has expressed futility at staying within the *Alice* framework. Since the Supreme Court has not shown a desire to re-visit its *Alice* decision, we are now left with the hope that Congressional legislation on eligibility might bring some much-needed clarity to this threshold requirement in patent law.

# APPENDICES

## APPENDIX A

Table A1. All Rejections for Mechanical and §§ 102, 103, and 112 Rejections by Technologies (Frequency, Percentage, and Total Office Actions (TOA))

| | Pre-*Alice* | | | Post-*Alice* Rejections for Applications Filed Before *Alice* | | | Post-*Alice* Rejections for Applications Filed After *Alice* | | |
|---|---|---|---|---|---|---|---|---|---|
| | Freq. | Pct. (%) | TOA | Freq. | Pct. (%) | TOA | Freq. | Pct. (%) | TOA |
| *Panel 1- Mechanical's § 101 Rejections and* Alice *Rejections* | | | | | | | | | |
| § 101 | 0 | 0 | 32,056 | 2 | 0.01 | 32,864 | 5 | 0.06 | 8,902 |
| *Alice* | 132 | 0.41 | 32,056 | 170 | 0.52 | 32,864 | 64 | 0.72 | 8,902 |
| *Panel 2-All § 102 Rejections* | | | | | | | | | |
| Mechanical | 10,443 | 32.58 | 32,056 | 11,318 | 34.44 | 32,864 | 3,579 | 40.2 | 8,902 |
| Bioinformatics | 1,253 | 25.69 | 4,877 | 1,531 | 26.06 | 5,875 | 248 | 32.59 | 761 |
| Bioinformatics (broad) | 8,584 | 27.29 | 31,450 | 6,767 | 29.31 | 23,086 | 2,302 | 35.67 | 6,454 |
| Business Methods | 76,087 | 30.47 | 249,738 | 75,517 | 32.07 | 235,478 | 31,982 | 35.62 | 89,792 |
| Business Methods of Finance | 2,803 | 17.63 | 15,900 | 3,699 | 23.16 | 15,972 | 439 | 23.76 | 1,848 |
| Business Methods of E-Commerce | 12,469 | 24.61 | 50,675 | 16,613 | 27.06 | 61,393 | 1,430 | 31.67 | 4,515 |
| Software (general) | 151,309 | 24.28 | 623,245 | 143,588 | 25.12 | 571,523 | 55,575 | 26.14 | 212,609 |
| AI | 2,144 | 32.79 | 6,539 | 1,629 | 28.55 | 5,706 | 300 | 28.36 | 1,058 |
| Graphical User Interface and Document Processing | 8,178 | 27.39 | 29,858 | 10,978 | 28.57 | 38,426 | 1,754 | 38.63 | 4,541 |
| Data Bases and File Management | 13,214 | 29.01 | 45,552 | 10,891 | 25.69 | 42,397 | 2,399 | 29.4 | 8,159 |
| Cryptography and Security | 9,895 | 21.84 | 45,315 | 8,464 | 25.04 | 33,804 | 3,800 | 22.93 | 16,574 |
| Computer Networks | 10,355 | 23.01 | 45,001 | 12,169 | 24 | 50,713 | 2,680 | 25.2 | 10,637 |
| Digital Cameras | 9,534 | 28.43 | 33,539 | 8,332 | 28.06 | 29,689 | 4,826 | 26.84 | 17,981 |
| Computer Graphics Processing | 3,573 | 14.7 | 24,303 | 4,072 | 21.13 | 19,269 | 1,201 | 21.47 | 5,593 |
| *Panel 3-All § 103 Rejections* | | | | | | | | | |
| Mechanical | 14,991 | 46.77 | 32,056 | 17,115 | 52.08 | 32,864 | 4,469 | 50.2 | 8,902 |
| Bioinformatics | 2,832 | 58.07 | 4,877 | 3,072 | 52.29 | 5,875 | 406 | 53.35 | 761 |
| Bioinformatics (broad) | 13,038 | 41.46 | 31,450 | 11,447 | 49.58 | 23,086 | 3,208 | 49.71 | 6,454 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Business Methods | 136,286 | 54.57 | 249,738 | 133,123 | 56.53 | 235,478 | 42,193 | 46.99 | 89,792 |
| Business Methods of Finance | 9,176 | 57.71 | 15,900 | 9,717 | 60.84 | 15,972 | 1,095 | 59.25 | 1,848 |
| Business Methods of E-Commerce | 35,646 | 70.34 | 50,675 | 45,715 | 74.46 | 61,393 | 3,096 | 68.57 | 4,515 |
| Software (general) | 342,693 | 54.99 | 623,245 | 329,849 | 57.71 | 571,523 | 109,377 | 51.45 | 212,609 |
| AI | 2,831 | 43.29 | 6,539 | 2,808 | 49.21 | 5,706 | 410 | 38.75 | 1,058 |
| Graphical User Interface and Document Processing | 21,583 | 72.29 | 29,858 | 28,119 | 73.18 | 38,426 | 3,199 | 70.45 | 4,541 |
| Data Bases and File Management | 26,551 | 58.29 | 45,552 | 26,156 | 61.69 | 42,397 | 4,334 | 53.12 | 8,159 |
| Cryptography and Security | 25,581 | 56.45 | 45,315 | 18,748 | 55.46 | 33,804 | 9,359 | 56.47 | 16,574 |
| Computer Networks | 25,350 | 56.33 | 45,001 | 30,910 | 60.95 | 50,713 | 5,621 | 52.84 | 10,637 |
| Digital Cameras | 15,879 | 47.34 | 33,539 | 13,416 | 45.19 | 29,689 | 7,056 | 39.24 | 17,981 |
| Computer Graphics Processing | 9,869 | 40.61 | 24,303 | 12,787 | 66.36 | 19,269 | 3,917 | 70.03 | 5,593 |
| *Panel 4-All § 112 Rejections* | | | | | | | | | |
| Mechanical | 24,395 | 76.1 | 32,056 | 10,463 | 31.84 | 32,864 | 3,049 | 34.25 | 8,902 |
| Bioinformatics | 2,165 | 44.39 | 4,877 | 2,677 | 45.57 | 5,875 | 348 | 45.73 | 761 |
| Bioinformatics (broad) | 14,045 | 44.66 | 31,450 | 10,818 | 46.86 | 23,086 | 3,343 | 51.8 | 6,454 |
| Business Methods | 69,784 | 27.94 | 249,738 | 75,612 | 32.11 | 235,478 | 28,594 | 31.84 | 89,792 |
| Business Methods of Finance | 4,594 | 28.89 | 15,900 | 5,328 | 33.36 | 15,972 | 622 | 33.66 | 1,848 |
| Business Methods of E-Commerce | 14,343 | 28.3 | 50,675 | 22,780 | 37.11 | 61,393 | 1,569 | 34.75 | 4,515 |
| Software (general) | 85,503 | 13.72 | 623,245 | 104,926 | 18.36 | 571,523 | 38,043 | 17.89 | 212,609 |
| AI | 1,049 | 16.04 | 6,539 | 1,080 | 18.93 | 5,706 | 181 | 17.11 | 1,058 |
| Graphical User Interface and Document Processing | 4,233 | 14.18 | 29,858 | 7,613 | 19.81 | 38,426 | 884 | 19.47 | 4,541 |
| Data Bases and File Management | 5,204 | 11.42 | 45,552 | 6,432 | 15.17 | 42,397 | 1,167 | 14.3 | 8,159 |
| Cryptography and Security | 7,282 | 16.07 | 45,315 | 7,129 | 21.09 | 33,804 | 3,411 | 20.58 | 16,574 |
| Computer Networks | 6,945 | 15.43 | 45,001 | 10,083 | 19.88 | 50,713 | 2,029 | 19.07 | 10,637 |
| Digital Cameras | 4,666 | 13.91 | 33,539 | 6,101 | 20.55 | 29,689 | 3,258 | 18.12 | 17,981 |
| Computer Graphics Processing | 2,261 | 9.3 | 24,303 | 4,349 | 22.57 | 19,269 | 1,119 | 20.01 | 5,593 |

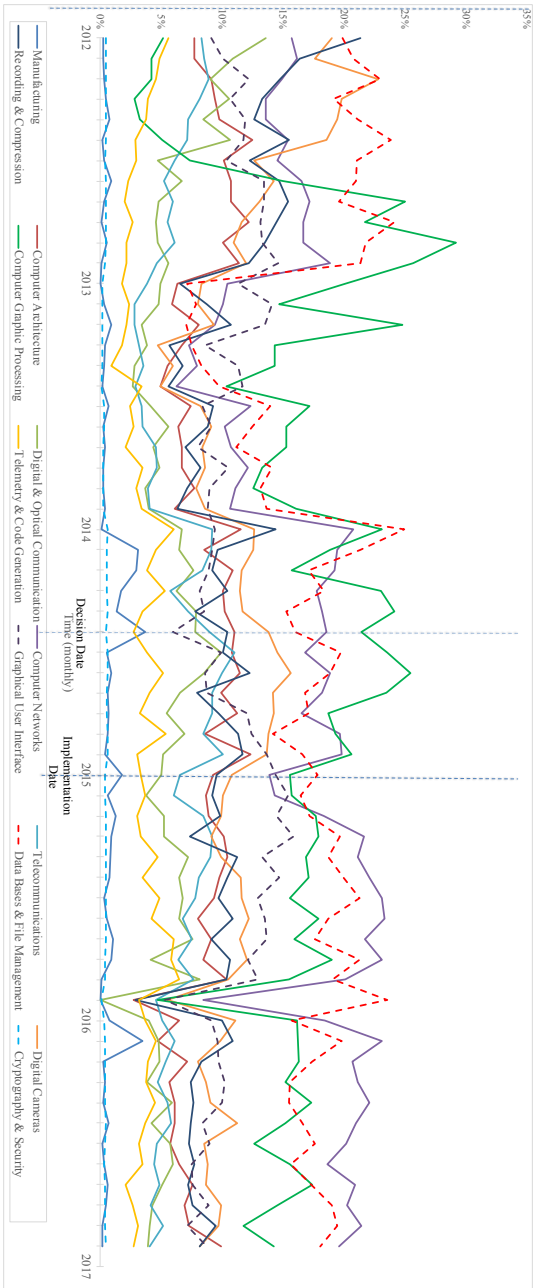


Figure A1. Monthly § 101 Rejections as a Fraction of All Office Actions Between 2012 and 2016

APPENDIX B

Table B1. Logistic Regressions to Estimate Rejections Based on *Alice*

*Panel 1.*

| Variables | Bioinformatics | Business Methods | B.M. of Finance | B.M. of E-Commerce | Software (general) |
|---|---|---|---|---|---|
| § 101 | 6.000*** | 5.292*** | 4.591*** | 4.341*** | 5.143*** |
| | (0.581) | (0.0842) | (0.224) | (0.0896) | (0.0542) |
| § 102 | 0.148* | -0.148*** | -0.0843** | -0.145*** | -0.0217 |
| | (0.0822) | (0.0178) | (0.0412) | (0.0225) | (0.0245) |
| § 103 | -0.457*** | 0.0386*** | 0.142*** | 0.0566*** | -0.0669** |
| | (0.0680) | (0.0182) | (0.0356) | (0.0243) | (0.0277) |
| Obj. | 6,636 | 205,006 | 17,820 | 54,523 | 711,048 |
| R-square | 0.284 | 0.476 | 0.163 | 0.192 | 0.473 |

| *Panel 2.* | Data Bases & File Management | Cryptography & Security | Telemetry & Code Generation | Digital Cameras | Computer Networks | Digital & Optical Communication |
|---|---|---|---|---|---|---|
| § 101 | 7.181*** | 5.363*** | 5.341*** | 3.440*** | 5.218*** | 7.550*** |
| | (0.454) | (0.173) | (0.263) | (0.131) | (0.129) | (0.999) |
| § 102 | 0.0705 | -0.227*** | 0.0646 | -0.312*** | -0.0701 | -0.556* |
| | (0.0732) | (0.0610) | (0.142) | (0.110) | (0.0534) | (0.322) |
| § 103 | 0.338*** | 0.377*** | 0.316** | 0.523*** | -0.607*** | -0.265 |
| | (0.0908) | (0.0821) | (0.151) | (0.120) | (0.0585) | (0.256) |
| Obj. | 47,999 | 49,478 | 55,357 | 47,025 | 60,697 | 20,457 |
| R-square | 0.473 | 0.438 | 0.462 | 0.382 | 0.429 | 0.500 |

Note: Month, art unit, and § 112 rejections are also controlled as fixed. *** p<0.01, ** p<0.05, * p<0.1.

APPENDIX C

Patent applications in manufacturing are the control group, which is compared to the treated groups. The specific technologies of business methods, bioinformatics, and software are considered individual treated groups. Thus, each technology type is individually applied with the same D-i-D designs, which are estimated as follows:

$$\text{logit}(\text{E}[Rej101_{itct1}|X_{itct1}]) = \ln\left(\frac{p_{itct1}}{1-p_{itct1}}\right) = \propto +\beta_1 Alice_{t1} + \beta_2 Tech_c + \beta_3 (Alice_{t1} * Tech_c) + \lambda Controls_{it} + \gamma_t + \varepsilon \quad (1)$$

$$p_{itct1} = \text{E}[Rej101_{itct1}|X_{itct1}] \quad (2)$$

where $i \in I = \{1, \dots, n\}$ , $t1 \in T_1 = \{1, 2\}$, $c \in C = \{1,2\}$ , $0<p<1$, and $t \in T = \{201201, \dots, 201612\}$. $I$ represents office actions. $n$ denotes the total number of office actions given to individual technology areas. $t_1$ denotes the intervention (i.e., *Alice* decision or the PTO implementation). $\varepsilon$ denotes an idiosyncratic error term uncorrelated with other independent variables or controls.

$Rej101$ indicates whether examiners gave a § 101 rejection. It equals 0 when the office action was an allowance and equals 1 when the office action was a rejection. $p_{itct1}$ denotes the probability of $Rej101$=1. The D-i-D models estimate the average degree of R&D intensity. $Tech_c$ and $Alice_{t1}$ absorb category- and event-fixed effects. The coefficient on the interaction, $\beta_3$, surrogates for the D-i-D effect. $\gamma_t$ denotes the month-fixed variable. The control variables for other statutory rejections (e.g., §§ 102, 103, and 112 rejections), industry category (e.g., technology centers or art units) are also included.

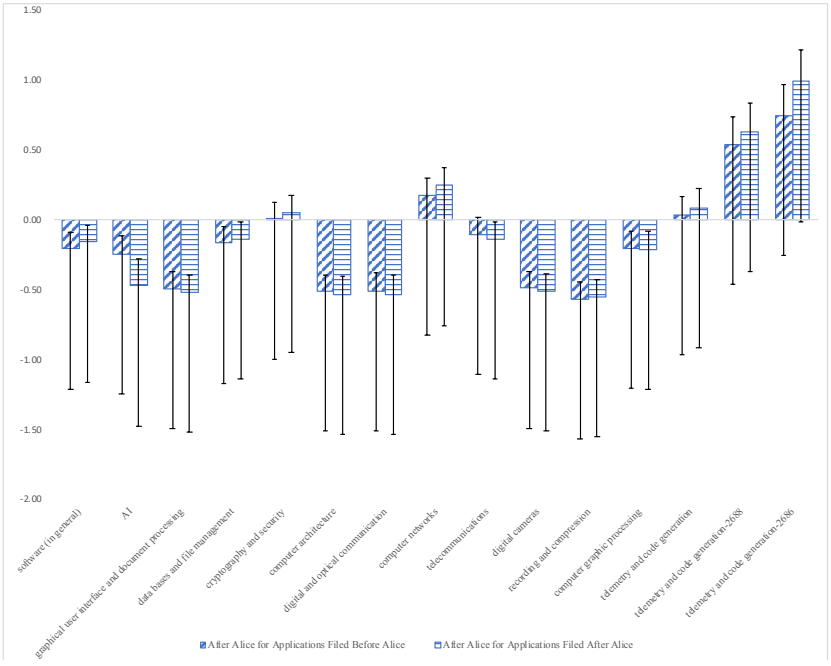

Figure C1. Coefficients of the Interaction Between *Alice* Decision and Technology to Estimate All § 101 Rejections with Error Bars in the Logit D-i-D Regressions

Table C1. Coefficient for the Interaction Term in D-i-D Logit Regressions on All § 101 Rejections

| Industry | | Applications filed Before *Alice* | | Applications filed After *Alice* | |
|---|---|---|---|---|---|
| | | Decision | Implementation | Decision | Implementation |
| Bioinformatics (broad) | Coeff. | 1.096*** | 1.185*** | 0.298* | 0.339** |
| | S.E. | (0.119) | (0.124) | (0.158) | (0.160) |
| | N. | 119,456 | 113,626 | 78,855 | 78,704 |
| Business Methods of Finance | Coeff. | 3.956*** | 4.098*** | 3.364*** | 3.356*** |
| | S.E. | (0.127) | (0.132) | (0.189) | (0.190) |
| | N. | 96,792 | 90,486 | 58,705 | 58,562 |
| Business Methods of E-Commerce | Coeff. | 3.032*** | 3.068*** | 2.448*** | 2.478*** |
| | S.E. | (0.119) | (0.124) | (0.163) | (0.165) |
| | N. | 176,988 | 167,351 | 96,146 | 95,900 |
| E-Commerce in Health Care | Coeff. | 3.482*** | 3.587*** | 3.402*** | 3.382*** |
| | S.E. | (0.132) | (0.136) | (0.264) | (0.264) |
| | N. | 80,764 | 76,430 | 48,964 | 48,868 |
| E-commerce in Cryptography | Coeff. | 2.899*** | 2.897*** | 2.934*** | 2.911*** |
| | S.E. | (0.152) | (0.155) | (0.311) | (0.311) |
| | N. | 69,489 | 65,600 | 43,123 | 43,046 |
| Software (general) | Coeff. | -0.210* | -0.161 | -0.145 | -0.169 |
| | S.E. | (0.117) | (0.122) | (0.154) | (0.156) |
| | N. | 1,259,686 | 1,169,402 | 876,807 | 874,155 |
| AI | Coeff. | -0.248* | -0.195 | -0.474** | -0.429** |
| | S.E. | (0.131) | (0.137) | (0.192) | (0.195) |
| | N. | 77,165 | 72,770 | 48,536 | 48,458 |
| Graphical User Interface and Document Processing | Coeff. | -0.492*** | -0.518*** | -0.426*** | -0.387** |
| | S.E. | (0.119) | (0.124) | (0.158) | (0.161) |
| | N. | 133,204 | 126,542 | 75,352 | 75,218 |

| | | | | | |
|---|---|---|---|---|---|
| Data Bases and File Management | Coeff. | -0.169 | -0.140 | 0.0669 | 0.108 |
| | S.E. | (0.118) | (0.123) | (0.157) | (0.160) |
| | N. | 152,869 | 143,014 | 94,669 | 94,510 |
| Cryptography and Security | Coeff. | 0.00513 | 0.0478 | 0.217 | 0.256 |
| | S.E. | (0.119) | (0.124) | (0.156) | (0.158) |
| | N. | 144,039 | 133,192 | 102,847 | 102,664 |
| Computer Architecture | Coeff. | -0.514*** | -0.535*** | -0.425*** | -0.397** |
| | S.E. | (0.121) | (0.127) | (0.159) | (0.162) |
| | N. | 143,504 | 134,346 | 98,047 | 97,846 |
| Digital and Optical Communication | Coeff. | -0.510*** | -0.536*** | -0.412** | -0.381** |
| | S.E. | (0.132) | (0.142) | (0.164) | (0.167) |
| | N. | 99,760 | 91,887 | 74,117 | 73,909 |
| Computer Networks | Coeff. | 0.175 | 0.243* | 0.456*** | 0.498*** |
| | S.E. | (0.119) | (0.124) | (0.158) | (0.160) |
| | N. | 160,634 | 151,302 | 96,596 | 96,431 |
| Telecommunications | Coeff. | -0.105 | -0.141 | -0.0969 | -0.0677 |
| | S.E. | (0.121) | (0.127) | (0.159) | (0.162) |
| | N. | 151,713 | 141,161 | 106,893 | 106,595 |
| Digital Cameras | Coeff. | -0.490*** | -0.514*** | -0.444*** | -0.411** |
| | S.E. | (0.121) | (0.128) | (0.159) | (0.161) |
| | N. | 128,148 | 118,533 | 92,473 | 92,117 |
| Recording and Compression | Coeff. | -0.572*** | -0.553*** | -0.547*** | -0.510*** |
| | S.E. | (0.122) | (0.127) | (0.162) | (0.165) |
| | N. | 116,345 | 110,758 | 69,840 | 69,685 |
| Computer Graphics Processing | Coeff. | -0.205* | -0.212* | 0.109 | 0.143 |
| | S.E. | (0.123) | (0.129) | (0.160) | (0.163) |
| | N. | 108,492 | 102,587 | 70,853 | 70,726 |
| Telemetry and Code Generation | Coeff. | 0.0350 | 0.0841 | 0.110 | 0.152 |
| | S.E. | (0.132) | (0.138) | (0.169) | (0.172) |
| | N. | 111,465 | 103,237 | 76,811 | 76,452 |
| Telemetry and Code | Coeff. | 0.537*** | 0.626*** | 0.257 | 0.285 |
| | S.E. | (0.197) | (0.208) | (0.232) | (0.235) |

| | | | | | |
|---|---|---|---|---|---|
| Generation-2688 | N. | 72,039 | 67,241 | 47,342 | 47,178 |
| Telemetry and Code Generation-2686 | Coeff. | 0.740*** | 0.986*** | 0.854*** | 0.934*** |
| | S.E. | (0.224) | (0.227) | (0.263) | (0.262) |
| | N. | 69,456 | 65,161 | 45,386 | 45,322 |

Note: James Stock's Heteroskedasticity-standard errors are in parentheses. The coefficient on the interaction term surrogates the D-i-D effect. Whether the office action also includes a § 102, § 103, or § 112 rejection is independently controlled as fixed in the model. Time (month) is a fixed control in the model. Technology center is controlled as fixed in software (general), graphical user interface and document processing, data bases and file management, and cryptography and security. Other models control art units as fixed. *** p<0.01, ** p<0.05, * p<0.1.

Table C2. D-i-D Logit Regressions on Final § 101 Rejections

| Industry | | Applications filed Before *Alice* | | Applications filed After *Alice* | |
|---|---|---|---|---|---|
| | | Decision | Implementation | Decision | Implementation |
| Bioinformatics (broad) | Coeff. | 2.581*** | 3.013*** | 2.593** | 2.593** |
| | S.E. | (0.612) | (0.643) | (1.031) | (1.031) |
| | N. | 2,383 | 2,301 | 705 | 705 |
| Business Methods of Finance | Coeff. | 4.014*** | 4.687*** | 4.084*** | 4.084*** |
| | S.E. | (0.636) | (0.633) | (0.939) | (0.939) |
| | N. | 7,683 | 7,331 | 2,175 | 2,175 |
| Business Methods of E-Commerce | Coeff. | 3.025*** | 3.651*** | 2.667*** | 2.603*** |
| | S.E. | (0.588) | (0.545) | (0.721) | (0.653) |
| | N. | 26,971 | 26,250 | 6,918 | 6,937 |
| E-Commerce in Health Care | Coeff. | 3.482*** | 3.587*** | 3.402*** | 3.382*** |
| | S.E. | (0.132) | (0.136) | (0.264) | (0.264) |
| | N. | 80,764 | 76,430 | 48,964 | 48,868 |
| E-commerce in Cryptography | Coeff. | 3.760*** | 3.597*** | 3.006* | 3.006* |
| | S.E. | (0.887) | (0.898) | (1.659) | (1.659) |
| | N. | 1,252 | 1,173 | 268 | 268 |
| Software (general) | Coeff. | 0.568 | 0.843 | 0.312 | 0.311 |
| | S.E. | (0.519) | (0.541) | (0.660) | (0.660) |
| | N. | 119,408 | 111,349 | 58,131 | 58,110 |

| | | | | | |
|---|---|---|---|---|---|
| AI | Coeff. | 0.706 | 0.974 | 0.412 | 0.412 |
| | S.E. | (0.597) | (0.630) | (0.866) | (0.866) |
| | N. | 1,553 | 1,426 | 695 | 695 |
| Graphical User Interface and Document Processing | Coeff. | 0.0510 | 0.223 | 0.0603 | 0.0605 |
| | S.E. | (0.515) | (0.540) | (0.861) | (0.861) |
| | N. | 8,782 | 8,374 | 3,084 | 3,084 |
| Data Bases and File Management | Coeff. | 0.199 | 0.457 | -0.0986 | -0.0986 |
| | S.E. | (0.517) | (0.541) | (0.671) | (0.671) |
| | N. | 13,164 | 12,231 | 5,297 | 5,298 |
| Cryptography and Security | Coeff. | 0.998* | 1.325** | 0.814 | 0.814 |
| | S.E. | (0.550) | (0.572) | (0.667) | (0.667) |
| | N. | 12,388 | 11,384 | 6,712 | 6,712 |
| Computer Architecture | Coeff. | 0.00697 | 0.352 | 0.200 | 0.200 |
| | S.E. | (0.562) | (0.604) | (0.773) | (0.773) |
| | N. | 6,487 | 5,939 | 3,329 | 3,329 |
| Digital and Optical Communication | Coeff. | 0.780 | 1.184* | 0.784 | 0.784 |
| | S.E. | (0.665) | (0.702) | (0.841) | (0.841) |
| | N. | 2,098 | 1,803 | 1,544 | 1,544 |
| Computer Networks | Coeff. | 0.560 | 0.865 | 0.634 | 0.634 |
| | S.E. | (0.556) | (0.613) | (0.760) | (0.760) |
| | N. | 12,994 | 12,232 | 4,615 | 4,615 |
| Telecommunications | Coeff. | -0.0546 | 0.283 | -0.410 | -0.410 |
| | S.E. | (0.596) | (0.655) | (0.850) | (0.850) |
| | N. | 5,786 | 5,303 | 2,912 | 2,912 |
| Digital Cameras | Coeff. | 0.194 | 0.550 | 0.0836 | 0.0843 |
| | S.E. | (0.616) | (0.672) | (0.853) | (0.854) |
| | N. | 6,841 | 6,293 | 4,246 | 4,242 |
| Recording and Compression | Coeff. | 0.226 | 0.545 | 0.574 | 0.574 |
| | S.E. | (0.570) | (0.619) | (0.829) | (0.829) |
| | N. | 4,847 | 4,652 | 1,967 | 1,967 |

| | | | | | |
|---|---|---|---|---|---|
| Computer Graphics Processing | Coeff. | 0.239 | 0.627 | 0.162 | 0.162 |
| | S.E. | (0.625) | (0.670) | (0.840) | (0.840) |
| | N. | 5,090 | 4,713 | 2,094 | 2,094 |
| Telemetry and Code Generation | Coeff. | 0.942 | 1.374** | 1.798* | 1.798* |
| | S.E. | (0.584) | (0.645) | (1.064) | (1.064) |
| | N. | 1,604 | 1,382 | 705 | 705 |

Note: James Stock's Heteroskedasticity-standard errors are in parentheses. The Coeff. on the interaction term surrogates the D-i-D effect. Whether the office action also includes a § 102, § 103, or § 112 rejection is independently controlled as fixed in the model. Time (month) is a fixed control in the model. Technology center is controlled as fixed in bioinformatics (broad), software (general), graphical user interface and document processing, data bases and file management, cryptography and security, and AI. Other models control art units as fixed. *** p<0.01, ** p<0.05, * p<0.1. *** p<0.01, ** p<0.05, * p<0.1

APPENDIX D

It is not enough to constitute a static D-i-D effect as an obsolete effect of the treatment, which is *Alice* in this study. Inventors, patent examiners, or patent attorneys who help with drafting patents and patent prosecution were reasonably changing their behaviors before the decision was delivered by the Supreme Court. "Anticipation is a reasonable diagnosis if individuals are forward-looking[] [and] have access to information on future treatment . . . ."[306] Therefore, it is critical to check not only the point of treatment but also the time before the treatment was adopted, which it leads. Besides the importance of the leads, lags of the treatment are also suitable instruments to control for people's unobservable forecast of the treatment or the anticipation.[307] Accordingly, equation 1 should be reformed as follows for anticipation effects:

$$y_{t1} = \lambda_0 d_{t1} + \sum_{j=1}^{T-t1} \lambda_j E_{t1}[d_{t1-j}] + \sum_{j=1}^{t1} \lambda_j E_{t1}[d_{t1+j}] + e_{t1} \quad (3)$$

$$d_{t1} = \text{logit}(E[Rej101_{itct1}|X_{itct1}]) \quad (4)$$

where $t1 \in T_1 = \{1, 2\}$, and $t \in T = \{201201, \ldots, 201612\}$. $t_1$ denotes the intervention (i.e., *Alice* decision or the implementation). $d_{t1}$ denotes the static D-i-D equation. $d_{t1+j}$ are a sequence of future values. $d_{t1+j}$ are a sequence of ex ante values. $E_{t1}$ denotes expectation taken with respect to a treatment at the *Alice* decision. $e_{t1}$ is an idiosyncratic error term uncorrelated with other independent variables.

The regression results in Table D1 show that patent applications for business methods and narrowly defined bioinformatics were more likely to receive a § 101 rejection at a statistically significant level, four months prior to the Supreme Court decision in *Alice*. That was February 2016, about two months after the Supreme Court granted the petition for a writ of certiorari from the United States Court of Appeals for the Federal Circuit on December 6, 2016. Therefore, the statistically significant effect prior to *Alice* may be explained by the anticipation effect—the USPTO examiners dynamically adjusted their examination strategies due to Supreme Court decisions.

306. Anup Malani & Julian Reif, *Interpreting Pre-Trends as Anticipation: Impact on Estimated Treatment Effects from Tort Reform*, 124 J. PUB. ECON. 1, 1–2 (2015).

307. Anup Malani & Julian Reif, *Accounting for Anticipation Effects: An Application to Medical Malpractice Tort Reform* 5 (John M. Olin L. & Econ. Working Paper No. 578, 2011), https://chicagounbound.uchicago.edu/cgi/viewcontent.cgi?article=1027&context=law_and_economics [https://perma.cc/7CLY-62MN]; *see also* Gregory C. Chow, *Rational Versus Adaptive Expectations in Present Value Models*, 71 REV. ECON. & STAT. 376 (1989) (examining rational expectations and adaptive expectations).

| Table D1. Logistic Regressions to Estimate § 101 Rejections | | |
|---|---|---|
| VARIABLES | Business Methods | Bioinformatics |
| (Note: Omitted:>5 months prior to *Alice* decision & >2 months after *Alice* decision) | | |
| 5-Month Prior to *Alice* Decision | 1.409 | 1.346 |
| | (0.916) | (0.917) |
| 4-Month Prior to *Alice* Decision | 2.497*** | 2.429*** |
| | (0.693) | (0.690) |
| 3-Month Prior to *Alice* Decision | 2.513*** | 2.466*** |
| | (0.683) | (0.680) |
| 2-Month Prior to *Alice* Decision | 2.018*** | 1.985*** |
| | (0.736) | (0.736) |
| 1-Month Prior to *Alice* Decision | 1.685** | 1.659** |
| | (0.768) | (0.766) |
| Month of *Alice* Decision | 2.549*** | 2.486*** |
| | (0.650) | (0.650) |
| 1-Month Post *Alice* Decision | 0.613 | 0.582 |
| | (0.915) | (0.917) |
| 2-Month Post *Alice* Decision | 1.210 | 1.112 |
| | (0.765) | (0.766) |
| 5-Month Prior to *Alice* Decision × Technology | -1.034 | -0.915 |
| | (0.919) | (0.984) |
| 4-Month Prior to *Alice* Decision × Technology | -2.275*** | -1.591** |
| | (0.696) | (0.795) |
| 3-Month Prior to *Alice* Decision × Technology | -2.458*** | -1.646** |
| | (0.687) | (0.806) |
| 2-Month Prior to *Alice* Decision × Technology | -1.866** | -1.365 |
| | (0.739) | (0.844) |
| 1-Month Prior to *Alice* Decision × Technology | -1.581** | -1.802** |
| | (0.771) | (0.851) |
| Month of *Alice* Decision × Technology | -2.440*** | -2.106*** |
| | (0.653) | (0.728) |
| | 0.255 | 1.021 |

| | | |
|---|---|---|
| 1-Month Post *Alice* Decision × Technology | (0.917) | (0.978) |
| 2-Month Post *Alice* Decision × Technology | -0.215 | 0.459 |
| | (0.767) | (0.846) |
| Constant | -6.881*** | 8.317 |
| | (0.577) | - |
| Observations | 513,954 | 71,355 |
| Pseudo R-squared | 0.1761 | 0.5665 |

Note: Whether the office action also includes a § 102, § 103, or § 112 rejection is independently controlled as fixed in the model. Time (month) is a fixed control in the model. Technology center is controlled as fixed. James Stock's Heteroskedasticity-standard errors are shown in parentheses, *** p<0.01, ** p<0.05, * p<0.1., *** p<0.01, ** p<0.05, * p<0.1.