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INTERRING THE PIONEER INVENTION DOCTRINE*

BRIAN J. LOVE**

This Article provides the first comprehensive analysis of patent law's "pioneer invention doctrine" in almost two decades. Since the early 1990s, patent scholars have unanimously reported that case law favoring so-called "pioneer" patents—i.e., those disclosing the most revolutionary inventions—is dead letter. Accordingly, most scholars have ignored the pioneer doctrine entirely. Those few who have studied it have consistently argued that the doctrine ought to be raised from the dead and reintroduced to patent law. This Article refutes scholarly consensus on both points. First, empirical evidence shows that the pioneer doctrine is still very much good law, especially at the district court level where it is routinely applied. In fact, the pioneer doctrine actually arises in litigation just as frequently as other issues that receive substantial scholarly attention. Second, this Article argues that the pioneer doctrine should now be excised from patent law once and for all, rather than returned to a place of prominence. Numerous aspects of patent law ensure that pioneer inventors receive generous patent rights without additional assistance. Further, the history of innovation strongly suggests that truly pioneering inventions do not exist. Despite the notoriety of inventors like Edison and Bell, a close reading of history shows that virtually all "pioneer" inventions were independently and contemporaneously invented by multiple groups working to solve the same known problems. Finally, case studies from various industries demonstrate that dominant pioneer patent rights generally stifle rather than promote innovation because they significantly discourage investment in the development of next-generation technology.

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INTRODUCTION

Hair awry, eyes wild, working like a mad scientist in the dead of the night. These are just some of the characteristics of the archetypical heroic inventor, a caricature born from the habits of men like Thomas Edison and Alexander Graham Bell, who in many ways embodied (or at least cultivated) this image during their lifetimes.¹ As a society, we lionize and mythologize these individuals as the singular geniuses who made our modern lives possible.²

It should come as no surprise then that U.S. patent law traditionally favors extraordinary technological advances: “pioneer

1. Edison, for example, abhorred sleep and frequently worked around the clock, catnapping when necessary, fully dressed on his workbench. See WYN WACHHORST, THOMAS ALVA EDISON: AN AMERICAN MYTH 37, 45 (1981) (noting Edison’s largely deserved reputation for sleepless marathons, including the infamous “phonograph vigil” during which Edison apocryphally worked for five days straight to perfect the phonograph). Always one to “cook up a good story” in the press, Edison also successfully cultivated an image as the eccentric “Wizard of Menlo Park.” See *id.* at 23, 36, 46 (noting, for example, press accounts of Edison as “a scientific hermit . . . working like an alchemist of old,” and several popular photographs “showing [Edison] in his white smock in a dingy room full of bottles, flasks, funnels, beakers, and tubing” or “with his shaggy brown-gray hair standing out at all angles”). Bell also was known for “[h]is tendency to work round the clock, and to alternate between states of fierce focus on one goal and an inability to concentrate on anything.” CHARLOTTE GRAY, RELUCTANT GENIUS: ALEXANDER GRAHAM BELL AND THE PASSION FOR INVENTION 114 (2006). Bell likewise cultivated a mystic image, demonstrating his telephone at sideshow-like “scientific demonstrations” alongside “clairvoyants, hypnotists, and levitationists.” *Id.* at 155–59.

2. See WACHHORST, *supra* note 1, at 4–5 (observing that in “American mythology” Edison is “the perfection of the typical American”: Charles Lindbergh, Merlin, Captain Ahab, Tom Sawyer, Horatio Alger, Benjamin Franklin, Prometheus, and “God himself” all rolled up into one). In 1922, a *New York Times* poll named Edison “the greatest living American”; in 1945, he ranked sixth on a list of the greatest people in world history, “outranked only by Jesus, FDR, Lincoln, Washington, and General MacArthur.” See *id.* at 5–6. The scientific community itself contributes to this mythology. Every young scientist “learns his field of study together with the names of the historical figures associated with its major discoveries.” D. LAMB & S.M. EASTON, MULTIPLE DISCOVERY: THE PATTERN OF SCIENTIFIC PROGRESS 19 (1984) (citing THOMAS S. KUHN, THE ESSENTIAL TENSION 165 (1977)).

inventions” in patent parlance.³ From the earliest days of the patent system, courts have rewarded the owners of pioneer inventions with exceptionally broad claim scope in exchange for their outsized technological contribution to society.⁴ This “pioneer invention doctrine,” which helped inventors like Edison, Bell, and Marconi turn their inventions into the technological giants we know today as General Electric, AT&T, and RCA, has over time influenced many aspects of patent law,⁵ not to mention the very history of innovation. Indeed, the notion that certain inventions should be exalted as “pioneers”—and the notoriety many such inventions and their creators have attained—has long shaped the way society views and values innovation.⁶

Nonetheless, today most believe the pioneer invention doctrine is dead letter. Conventional wisdom in the patent literature states that

3. See John R. Thomas, *The Question Concerning Patent Law and Pioneer Inventions*, 10 HIGH TECH. L.J. 35, 37 (1995) (“[L]aypersons and technologists share the view that pioneer inventions are crucial to the sort of technological advance that the patent system is designed to encourage. They are the inventions with which we are most familiar, and those we care most about.” (footnote omitted)). Indeed, it is quite intuitive to extend special rewards, via the patent system or otherwise, to those whose creations brought radical benefits to society. See Carl Shapiro, *Patent Reform: Aligning Reward and Contribution*, in 8 INNOVATION POLICY AND THE ECONOMY 111, 115 (Adam B. Jaffe et al. eds., 2007) (noting that it is intuitive to assume that the patent system generally undercompensates inventors because “many inventions generate positive externalities, generally known as spillovers” that might not be reflected in patent rewards). On the intuitive appeal of extending greater patent rights to pioneer inventors, see Michael J. Meurer & Craig Allen Nard, *Invention, Refinement and Patent Claim Scope: A New Perspective on the Doctrine of Equivalents*, 93 GEO. L.J. 1947, 1989 (2005); Georgia E. Kralovic, Comment, *The Principle of Fair Notice: Is It Prudent Guidance for the Future of Patent Law?*, 26 PEPP. L. REV. 89, 104–05 (1998). Great inventors, of course, also receive many rewards that have nothing to do with the patent system. During his lifetime, Edison was rewarded “with countless banquets, prizes, celebrations, expositions, titles, tributes, medals, monuments, and memorials.” WACHHORST, *supra* note 1, at 5. Others, like Guglielmo Marconi, William Shockley, Charles Townes, and Jack Kilby, were awarded the Nobel Prize. See *All Nobel Prizes*, NOBELPRIZE.ORG, http://nobelprize.org/nobel_prizes/lists/all/ (last visited Jan. 1, 2012).

4. See, e.g., *Westinghouse v. Boyden Power Brake Co.*, 170 U.S. 537, 561–62 (1898) (defining a “pioneer” as “a patent covering a function never before performed, a wholly novel device, or one of such novelty and importance as to mark a distinct step in the progress of the art”).

5. In a variety of contexts, especially in the analysis of conflicting patent rights, patents are labeled as either “pioneers” or “improvements.” See *infra* notes 93–98 and accompanying text.

6. Even schoolchildren know of great inventors like Edison, Morse, Howe, Bell, Fulton, Marconi, and the Wright brothers. See, e.g., *Mother Necessity*, SCHOOLHOUSE ROCK, <http://www.schoolhouserock.tv/Mother.html> (last visited Jan. 1, 2012). Society, it seems, is always looking for the next name to add to this list. See, e.g., Michael Judge, *In Search of the Next Edison*, WALL ST. J., July 16, 2010, at W7A.

the doctrine was killed more than twenty years ago by the Federal Circuit's opinion in *Texas Instruments, Inc. v. United States International Trade Commission*.⁷ Thus, for decades, most scholars of the patent system have ignored the pioneer doctrine altogether, and those few scholars who have examined it have considered only whether the doctrine ought to be brought back to life and reintroduced in patent law.

This Article undertakes the first comprehensive examination of the pioneer doctrine in more than fifteen years and turns this conventional wisdom on its head. First, Part I shows that the pioneer doctrine is still very much alive. Both at the Federal Circuit and in lower courts, patentees routinely invoke the pioneer doctrine to argue for broadened claim scope. In fact, the doctrine has been raised in recent years just as frequently as other doctrines that attract substantial scholarly attention. More importantly, courts have time and again considered the pioneer status of patented inventions when applying the doctrine of equivalents and have, in many cases since the doctrine's supposed death, awarded pioneer status to patents.

Further, there is good reason to believe that the pioneer doctrine is poised to retake its former place of prominence in patent law. Much as the last century saw the emergence of complex mechanical and computerized systems, this century promises to be one of marked growth in biotechnology.⁸ As the innovation economy begins to transition away from cumulative, fast-evolving technologies and toward those that require costly and prolonged periods of development, scholars have suggested that the pioneer invention doctrine ought to play a role in incentivizing firms to make the substantial investment required to bring successful biopharmaceutical products to market.⁹ Whether and how patent law adapts to this rising

7. 846 F.2d 1369, 1370 (Fed. Cir. 1988).

8. See BIOTECHNOLOGY STRATEGY COUNCIL, BIOTECHNOLOGY STRATEGY GUIDELINES 4 (2002), reprinted in KATHY WILSON PEACOCK, BIOTECHNOLOGY AND GENETIC ENGINEERING 192, 192 (2010) ("The 21st Century is the Life Sciences Century . . ."); JEREMY RIFKIN, THE BIOTECH CENTURY: HARNESSING THE GENE AND REMAKING THE WORLD 1-4 (1998); Hank Greely, *Law and the Biosciences*, STAN. LAW., Spring 2011, at 36, 37 ("It has been said that, as the 20th century was the century of physics, the 21st will be the century of biology.").

9. See Dan L. Burk & Mark A. Lemley, *Biotechnology's Uncertainty Principle*, 54 CASE W. RES. L. REV. 691, 738 (2004) [hereinafter Burk & Lemley, *Biotechnology*] (suggesting that "rejuvenating the doctrine of pioneer patents" may help "to minimize the anticommons problems and give inventors sufficient control to induce them to walk the uncertain path towards commercial development" in the biotechnology industry); Dan L. Burk & Mark A. Lemley, *Policy Levers in Patent Law*, 89 VA. L. REV. 1575, 1683 (2003) [hereinafter Burk & Lemley, *Policy Levers*] (same); see also John Mills, *Three "Non-*

tide of innovation will dictate the effectiveness of the patent system in the twenty-first century.

Second, while the pioneer doctrine remains among the living, this Article argues that it should now be interred once and for all. As discussed in Part II, proponents of the doctrine's resurgence justify their claim on two principal grounds: that imperfections in the patent application process deny groundbreaking inventors adequate patent scope and that extending broad rights to early inventors leads to more innovation. They are wrong on both counts.

Part III shows that patent doctrine already ensures that groundbreaking inventions receive remarkably broad patent protection. By definition, pioneer inventions arise in fields with limited prior art and, therefore, will generally be protected by broad patent claims. These claims, moreover, will naturally expand with time as technical terminology evolves and hindsight bias takes effect. Further, pioneer inventors can, themselves, expand their claims years later by filing reissue and continuation applications.

Next, the history of innovation strongly suggests that truly pioneering inventions exist only in popular imagination. Despite the fame of inventors like Edison and Bell, the historical record contradicts the notion that modern technology was largely developed through the unprecedented efforts of a select few heroic inventors. To the contrary, virtually all pioneer inventions were independently and contemporaneously invented by multiple groups working to solve the same known problems. For every Edison or Bell fondly remembered, there exist numerous Swans, Brushes, Reises, and Grays of equal talent whose names and accomplishments are all but lost to history.¹⁰ That lone individuals ultimately won the rights to so many of the most noteworthy inventions—both as a legal matter and in the hearts and minds of future generations—resulted more from their superior marketing and political acumen than technological merit or foresight.¹¹

Obvious Modifications to Simplify and Rein in the Doctrine of Equivalents, 14 FED. CIR. B.J. 649, 653 (2005) (acknowledging the argument that “in certain areas of new technology, such as biotechnology” a patentee’s “only viable means for bringing an infringement claim” is to rely on a broad application of the doctrine of equivalents).

10. See *infra* Part III.B.1.a.

11. Much of Edison’s mystique, for example, was the result of sensational press coverage and masterful advertising. See WACHHORST, *supra* note 1, at 37, 41, 43–44. James Watt’s successful domination of the steam engine industry in the United Kingdom would not have been possible without an Act of Parliament extending his patent rights, originally granted in January 1769, until 1800. See MICHELE BOLDRIN & DAVID K. LEVINE, AGAINST INTELLECTUAL MONOPOLY 1, 3 (2008) (linking Watt’s term extension

Finally, history and economic theory predict that dominant pioneer patent rights stifle far more innovation than they promote. Simple analysis of licensing negotiations between the owners of blocking patents demonstrates that early inventors with broad patent claims will hold up later inventors of improved technology, a fact that significantly discourages investment in the development of next-generation products. Numerous industry case studies support this analysis. Throughout history, dominant pioneer firms have consistently worked to suppress, rather than create, superior new products.

Importantly, this result holds true across industries, including the pharmaceutical and biotech sectors. While the pioneer doctrine makes the most intuitive sense in fields where innovation is risky and expensive, calls for enhanced protection of biopharmaceuticals generally overstate the true cost of product development in the industry and the role patent law plays in inducing the creation of new treatments and diagnostics. Pharmaceutical and biomedical research, despite its nominally high cost, is heavily subsidized by the government and is often sparked by the unpatentable discoveries of university researchers working in the pure sciences. Indeed, broad swaths of medical research have already been claimed by university-affiliated firms that have proven more successful at extracting steep royalties than developing treatments and diagnostics.

At their core, these findings and the analysis that follows expose many fundamental pillars of the patent system as gross oversimplifications with little or no empirical basis. Modern innovation is emphatically not the result of singular strokes of genius. Dominant pioneer firms do not in practice work diligently to develop their inventions and greater patent rewards do not always incentivize greater inventive output. To the extent these popular notions of invention were ever accurate, the pioneer doctrine should be seen as a relic of that era whose departure from the present is long overdue.

I. THE PIONEER INVENTION DOCTRINE

From the earliest days of the U.S. patent system, courts have generously interpreted the scope of patents covering important inventions. This part summarizes the history of the pioneer invention

to the political connections of Watt's wealthy business partner, Matthew Boulton). Similarly, Marconi's ability to win broad patent rights covering early radio technology was likely due in part to his aristocratic family and connections to the likes of Edison and Andrew Carnegie. *See id.* at 204-05.

doctrine from its eighteenth century origins to its role in modern patent infringement litigation and shows that, contrary to conventional wisdom among patent scholars, courts still routinely search for pioneer inventions.

A. Determinants of Patent Scope

The scope of protection a patent affords its owner—that is, the breadth of her right to exclude rivals from making or using certain technology—is the result of a long-running and complex sequence of events that begins when an inventor applies for patent protection. To obtain a patent in the United States, an inventor must file an application with the Patent and Trademark Office (“PTO”) showing that her invention is novel,¹² useful,¹³ and non-obvious.¹⁴ She must also describe her invention with specificity sufficient to enable others with knowledge of the relevant art to make and use the invention.¹⁵

Modern patent applications have two distinct parts: first, a “specification” in which the applicant describes her invention in technical terms and, second, a set of one or more “claims” in which the applicant defines the scope of her invention in legal terms.¹⁶ A patent applicant is free to draft her claims as broadly as she believes

12. See 35 U.S.C. § 102 (2006). The America Invents Act amends 35 U.S.C. § 102 to establish a first-to-file patent system in which the first inventor to file a patent application will win rights to the invention. See Leahy-Smith America Invents Act, Pub. L. No. 112-29, § 3(b), 125 Stat. 284, 285–87 (2011). This provision will go into effect eighteen months after September 16, 2011, the date the Act was enacted. See § 3(n)(1), 125 Stat. at 293.

13. See 35 U.S.C. § 101.

14. See § 103. The America Invents Act makes conforming changes to § 103 based on the first-to-file regime, providing that a patent will not issue “if the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention.” § 3(c), 125 Stat. at 287. Like the revisions to § 102, these changes to the obviousness standard will not take effect until eighteen months after September 16, 2011. See § 3(n)(1), 125 Stat. at 293.

Though not expressly required by statute, courts have also long held that certain discoveries are not patentable, namely discoveries of “laws of nature, physical phenomena, and abstract ideas.” See *Bilski v. Kappos*, 130 S. Ct. 3218, 3225 (2010) (quoting *Diamond v. Chakrabarty*, 447 U.S. 303, 309 (1980)). Thus, as a practical matter, there is also a fourth “patentable subject matter” requirement.

15. See 35 U.S.C. § 112 (“The specification shall contain a written description of the invention . . . in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains . . . to make and use the same, and shall set forth the best mode contemplated by the inventor of carrying out his invention.”). The America Invents Act makes minor, conforming changes to § 112. See § 4(c), 125 Stat. at 296. These changes go into effect one year from the date the Act was enacted, September 16, 2011. § 4(e), 125 Stat. at 297.

16. See § 112 (“The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or joint inventor regards as the invention.”).

possible, subject to the limitations of the novelty, non-obviousness, and enablement requirements. Claims so broad that they cover existing technology—i.e., the “prior art”—are unpatentable because they fail the novelty requirement.¹⁷ Claims that merely cover obvious modifications to the prior art are likewise invalid.¹⁸ And, claims drafted so broadly that they cover novel technology beyond what the applicant described in her specification are invalid for “lack of enablement.”¹⁹

At the PTO, a patent examiner is assigned to review each patent application for compliance with these requirements. Examiners locate prior art relevant to the invention disclosed in the application, compare that art with the applicant’s claims, and reject any claims they believe to be overbroad.²⁰ An applicant may then narrow her rejected claims and resubmit them for subsequent rounds of consideration.²¹ This back-and-forth process may run through multiple iterations before the examiner deems any claims patentable.²²

Though a patent’s claims are usually fixed as of the date the patent issues,²³ the effective scope of those claims is unlikely to be

17. See, e.g., *Verdegal Bros. v. Union Oil Co. of Cal.*, 814 F.2d 628, 631 (Fed. Cir. 1987) (holding that a claim is invalid under 35 U.S.C. § 102 if “each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference”).

18. See, e.g., *Graham v. John Deere Co.*, 383 U.S. 1, 17 (1966) (holding that obviousness is to be determined by comparing “differences between the prior art and the claims at issue”).

19. See, e.g., *In re Wright*, 999 F.2d 1557, 1561 (Fed. Cir. 1993) (“[T]o be enabling, the specification of a patent must teach those skilled in the art how to make and use the full scope of the claimed invention without ‘undue experimentation.’”).

20. See, e.g., Michael Risch, *The Failure of Public Notice in Patent Prosecution*, 21 HARV. J.L. & TECH. 179, 182–84 (2007) (describing this process in greater detail).

21. *Id.* at 184. As discussed *infra*, an applicant may continue prosecuting a family of patent applications until the term of protection for her initial application expires. See *infra* notes 203–04 and accompanying text.

22. On average, patent applications spend about three years in prosecution. See John R. Allison & Mark A. Lemley, *The Growing Complexity of the United States Patent System*, 82 B.U. L. REV. 77, 98 (2002) (finding that patents issued between 1996 and 1998 spent an average of 2.77 years in prosecution). Many spend considerably longer. See Mark A. Lemley & Kimberly A. Moore, *Ending Abuse of Patent Continuations*, 84 B.U. L. REV. 63, 121–23 (2004) (finding that more than 13,000 patent applications spent ten years or longer in prosecution between 1976 and 2000). Taking continuation applications into account, the PTO grants patents to more than seventy percent of applicants. Mark A. Lemley & Bhaven Sampat, *Is the Patent Office a Rubber Stamp?*, 58 EMORY L.J. 181, 192–93 (2008) (examining nearly 10,000 patent applications filed in January 2001).

23. In rare cases a patentee may apply within two years to have his patent “reissued” with new, broader claims. See 35 U.S.C. § 251 (2006); see also *infra* notes 164–68 and accompanying text (describing the process of patent reissuance in greater detail).

clear until after the patent's owner, or "patentee," files suit to assert his rights against an alleged infringer—i.e., another entity making or using her invention without permission. A patentee can allege that an accused infringer's product or process infringes her patent rights in two ways. First, she can allege that the infringer's technology "literally" infringes her patent by falling within the express language of one of the patent's claims.²⁴ Because patentees and alleged infringers rarely agree about the literal scope of patent claims,²⁵ courts typically reserve judgment about literal infringement until after issuing a *Markman* ruling defining disputed claim terms or phrases.²⁶

Accused infringers who escape a finding of literal infringement may still be held liable for infringement by "equivalents." Under longstanding precedent known as the "doctrine of equivalents," accused technology falling outside the literal scope of a patentee's claims will nevertheless infringe the patentee's rights if it "performs substantially the same function in substantially the same way to obtain the same result."²⁷

24. See *Warner-Jenkinson Co. v. Hilton Davis Chem. Co.*, 520 U.S. 17, 21 (1997) (distinguishing between accused devices that "literally infringe upon the express terms of a patent claim" and those that infringe under "the 'doctrine of equivalents'").

25. See Mark A. Lemley & Carl Shapiro, *Probabilistic Patents*, J. ECON. PERSP., Spring 2005, at 75, 85 ("The meaning of patent claim terms—called 'claim construction'—is hotly debated in virtually every patent case, and courts have found ambiguity even in such innocuous terms as 'a,' 'or,' 'to' and 'when.'").

26. These rulings are named after *Markman v. Westview Instruments, Inc.*, 517 U.S. 370 (1996), the case in which the Supreme Court first held that claim interpretation is a question of law reserved to courts. See *id.* at 372.

27. *Graver Tank & Mfg. Co. v. Linde Air Prods. Co.*, 339 U.S. 605, 608 (1950) (quoting *Sanitary Refrigerator Co. v. Winters*, 280 U.S. 30, 42 (1929)) (internal quotation marks omitted). Claims brought under the doctrine of equivalents are substantially less successful than claims for literal infringement. Compare John R. Allison & Mark A. Lemley, *The (Unnoticed) Demise of the Doctrine of Equivalents*, 59 STAN. L. REV. 955, 963, 967 (2007) (finding that, between May 1999 and August 2005, patentees proved infringement under the doctrine of equivalents in approximately seven percent of cases in which the issue was raised), with ARON LEVKO, VINCENT TORRES & JOSEPH TEELUCKSINGH, PRICEWATERHOUSECOOPERS, A CLOSER LOOK: 2008 PATENT LITIGATION STUDY: DAMAGES AWARDS, SUCCESS RATES AND TIME-TO-TRIAL 8 & fig.5A (2008), available at http://www.pwc.com/en_US/us/forensic-services/assets/2008_patent_litigation_study.pdf (finding that, between 1995 and 2007, patentees won thirty-seven percent of the time in cases decided on summary judgment or at trial). Also, in rare cases, courts will excuse infringement—even literal infringement—under the so-called "reverse" doctrine of equivalents because the infringing device is "so far changed in principle that it performs in a substantially different way and is not therefore an appropriation." *SRI Int'l v. Matsushita Elec. Corp. of Am.*, 775 F.2d 1107, 1123 (Fed. Cir. 1985) (en banc) (emphasis omitted) (internal quotation marks omitted).

Courts enjoy considerable discretion in determining what range of equivalents fall within a patentee's rights²⁸ and, traditionally, have exercised this discretion in relation to the importance of the patented invention. When a patent covers only a mere improvement to the prior art, courts generally afford the patent a very narrow range of equivalents, thereby limiting the patentee's rights essentially to her literal claims.²⁹ Conversely, when courts have found that a patent is a pioneer—that is, a “patent covering a function never before performed, a wholly novel device, or one of such novelty and importance as to mark a distinct step in the progress of the art”—courts customarily reward the inventor with a broad range of equivalents, thereby permitting her to claim ownership of technology lying substantially beyond the literal scope of her claims.³⁰ Though many pioneer inventions have been recognized over the years,³¹ courts have consistently held that the “[m]ost conspicuous examples of such patents are: The one to Howe of the sewing machine; to Morse of the electrical telegraph; and to Bell of the telephone.”³²

B. “Pioneer” Patents and the Doctrine of Equivalents

While the notion that certain patents qualify as pioneers has most recently been applied to expand claim scope as part of the doctrine of equivalents, precedent favoring pioneer inventions dates back to the founding of the U.S. patent system, well before the doctrine of equivalents or patent claims existed.

Early versions of the U.S. Patent Act did not require inventors to define their inventions using a set of claims.³³ Instead, inventors were only required to provide a “specification . . . to distinguish the

28. See Robert P. Merges & Richard R. Nelson, *On the Complex Economics of Patent Scope*, 90 COLUM. L. REV. 839, 841–42 (1990) (explaining that patent law principles leave courts “considerable room for discretion”); Thomas, *supra* note 3, at 44 (“Courts employing the doctrine of equivalents face a policy choice when considering the range of equivalents that should be granted to patent holders.”).

29. See, e.g., *Kinzenbaw v. Deere & Co.*, 741 F.2d 383, 389 (Fed. Cir. 1984).

30. *Westinghouse v. Boyden Power Brake Co.*, 170 U.S. 537, 561–62 (1898). Over the years, courts have used various terminology to describe pioneer patents. See Thomas, *supra* note 3, at 48 (“Courts have considered an invention to be a pioneer when it presents a ‘broad breakthrough,’ ‘major advance,’ or ‘basic operational concept’; or is ‘broadly new’ or ‘devoid of significant prior art.’ Pioneer inventions have alternatively been called primary, basic, generic, original, or key inventions.” (footnotes omitted)); see also *Am. Stainless Steel Co. v. Ludlum Steel Co.*, 290 F. 103, 106 (2d Cir. 1923) (referring to pioneers as patents leading to the “development of a new branch of industry”).

31. See *infra* note 57.

32. *Westinghouse*, 170 U.S. at 562.

33. See U.S. Patent Act of 1793, ch. 11, § 3, 1 Stat. 318, 321–22 (repealed 1836); U.S. Patent Act of 1790, ch. 7, § 2, 1 Stat. 109, 110–11 (repealed 1793).

invention or discovery from other things before known and used.”³⁴ During this period, patents were said to cover all “substantially similar” technology operating under the same “principle.”³⁵ Litigation, therefore, required courts to distill the principle of the invention-at-issue from the inventor’s disclosure.³⁶ In early cases, courts set patent scope in relation to the importance of the invention, holding that patents merely improving existing technology were narrow in principle³⁷ while patents on wholly new technology were broad.³⁸

The gradual introduction of patent claims during the first half of the nineteenth century initially did little to alter this principle-based infringement analysis.³⁹ During this era of “central claiming,” patent claims were viewed as merely drawing attention to what the inventor viewed as the central principles of his invention. As before, courts allowed patent rights to stretch in relation to the degree of the

34. U.S. Patent Act of 1790 § 2.

35. See *Winans v. Denmead*, 56 U.S. (15 How.) 330, 342 (1853); *Evans v. Eaton*, 20 U.S. (7 Wheat.) 356, 361 (1822) (“[I]f the two machines be substantially the same, and operate in the same manner, to produce the same result, though they may differ in form, proportions, and utility, they are the same in principle . . .”). See generally Joshua D. Sarnoff, *The Historic and Modern Doctrines of Equivalents and Claiming the Future: Part I (1790–1870)*, 87 J. PAT. & TRADEMARK OFF. SOC’Y 371 (2005) (examining the early history of infringement by equivalents).

36. U.S. Patent Act of 1793 § 3 (requiring patentees to “fully explain the principle . . . by which [their invention] may be distinguished from other inventions”); Karl B. Lutz, *Evolution of the Claims of U.S. Patents (Part II)*, 20 J. PAT. OFF. SOC’Y 377, 377–78 (1938).

37. These concepts were initially developed by Justice Joseph Story in several opinions he wrote while circuit riding. These early cases typically involved challenges to patent validity, rather than infringement. See, e.g., *Odiorne v. Winkley*, 18 F. Cas. 581, 582 (C.C.D. Mass. 1814) (No. 10,432) (“If another person invent[s] an improvement on [a patented] machine, he can entitle himself to a patent for such improvement only . . .”); *Woodcock v. Parker*, 30 F. Cas. 491, 492 (C.C.D. Mass. 1813) (No. 17,971) (“[I]f the machine, for which the plaintiff obtained a patent, substantially existed before, and the plaintiff made an improvement only therein, he is entitled to a patent for such improvement only . . .”).

38. See *Evans*, 20 U.S. (7 Wheat.) at 430–35 (interpreting a patent in the prior art broadly to invalidate the patent-in-suit, which the court viewed as a mere improvement).

39. Faced with the often difficult task of determining a patented invention’s novel principle from the specification alone, some courts began to interpret the Patent Act as requiring inventors to include language in their specifications identifying which aspects of their invention were novel compared to the prior art. See Dan L. Burk & Mark A. Lemley, *Fence Posts or Sign Posts? Rethinking Patent Claim Construction*, 157 U. PA. L. REV. 1743, 1767 (2009). Many patent applicants responded to these court rulings by including a separate statement at the end of their specifications “claiming” their invention’s novel features. *Id.* This practice was codified in the Patent Act of 1836. U.S. Patent Act of 1836, ch. 357, § 6, 5 Stat. 117, 119 (requiring patent applicants to “particularly specify and point out the part, improvement, or combination, which he claims as his own invention or discovery”).

invention's advancement over the existing art. Patents "introduc[ing] a mode of operation not before employed" enjoyed broad scope,⁴⁰ while patents disclosing "an improvement . . . not founded on any new discovery" received narrow protection.⁴¹

It was not until the latter half of the nineteenth century that patent law's focus on discerning inventive principles slowly morphed into the now familiar two-part infringement inquiry. The Patent Act of 1870 for the first time required applicants to "particularly point out and distinctly claim" the novel aspects of their inventions.⁴² By that time, courts and patentees generally regarded patent claims as establishing the periphery, rather than the core, of patent rights,⁴³ and infringement analysis began to focus on the literal scope of claim language.⁴⁴ The notion that the breadth of patent rights was in some sense an equitable determination survived this transition, however, and became a second step in the infringement determination, a precursor to the modern doctrine of equivalents available to pioneer inventors.⁴⁵ As the Supreme Court summarized the doctrine in 1889,

This principle is well settled in the patent law, both in this country and in England. Where an invention is one of a primary character, and the mechanical functions performed by the machine are, as a whole, entirely new, all subsequent machines which employ substantially the same means to accomplish the same result are infringements, although the subsequent

40. *Winans*, 56 U.S. (15 How.) at 339; *see also* *McCormick v. Talcott*, 61 U.S. (20 How.) 402, 405 (1857) ("If he be the original inventor of the device . . . , he will have a right to treat as infringers all who make [similar devices] operating on the same principle, and performing the same functions by analogous means or equivalent combinations . . .").

41. *Burr v. Duryee*, 68 U.S. (1 Wall.) 531, 574 (1863); *see also* *McCormick*, 61 U.S. (20 How.) at 405 ("[I]f the invention claimed be itself but an improvement on a known machine . . . [t]he inventor . . . cannot invoke the doctrine of equivalents to suppress all other improvements which are not mere colorable invasions of the first.").

42. U.S. Patent Act of 1870, ch. 230, § 26, 16 Stat. 198, 201.

43. *See* *Burk & Lemley*, *supra* note 39, at 1770 ("[T]he role of peripheral claiming was well established by the end of the nineteenth century . . .").

44. *See* *Merrill v. Yeomans*, 94 U.S. 568, 570 (1876) ("This distinct and formal claim is . . . of primary importance, in the effort to ascertain precisely what it is that is patented to the appellant in this case."); *Brooks v. Fiske*, 56 U.S. (15 How.) 212, 215 (1853) ("[W]e are to look at the [specification and drawings] only for the purpose of enabling us correctly to interpret the claim.").

45. *See generally* Joshua D. Sarnoff, *The Historic and Modern Doctrines of Equivalents and Claiming the Future: Part II (1870–1952)*, 87 J. PAT. & TRADEMARK OFF. SOC'Y 441 (2005) (detailing the emergence of the modern doctrine of equivalents after the Patent Act of 1870). The Supreme Court coined the phrase "doctrine of equivalents" in 1857. *See McCormick*, 61 U.S. (20 How.) at 405.

machine may contain improvements in the separate mechanisms which go to make up the machine.⁴⁶

As this quote suggests, the nascent doctrine of equivalents was available *only* to pioneer inventions.⁴⁷ If the patentee was not “a pioneer in the art,” he was not “allowed to invoke the doctrine of equivalents.”⁴⁸

It was not until decades later, after the turn of the twentieth century, that the modern doctrine of equivalents began to take shape. In *Continental Paper Bag Co. v. Eastern Paper Bag Co.*,⁴⁹ the Supreme Court held for the first time that a non-pioneer patent could benefit from the doctrine of equivalents.⁵⁰ In that case, the Court applied the doctrine to a patent that, though not a pioneer, was nonetheless a patent “of high rank.”⁵¹ In the decades that followed, courts continued to expand the doctrine’s application to patents that, while not pioneers, were deemed sufficiently important to warrant protection from equivalents.⁵²

By 1950, rules favoring pioneer patents had completely transitioned from *the* doctrine of equivalents to merely *part of* the doctrine of equivalents. In *Graver Tank & Manufacturing Co. v. Linde Air Products*,⁵³ the Supreme Court extended the doctrine of equivalents to all patents, making clear for the first time that any patented invention—even “a secondary invention consisting of a combination of old ingredients”—could be infringed by equivalents.⁵⁴ In doing so, the Court also cast the doctrine of equivalents in a new light. Downplaying the doctrine’s long history as a protector of only the most groundbreaking inventions, the Court instead described the doctrine as a fundamental pillar of the patent system: one without which an “unscrupulous copyist [making] unimportant and

46. *Morley Sewing Mach. Co. v. Lancaster*, 129 U.S. 263, 273 (1889).

47. *See, e.g., Miller v. Eagle Mfg. Co.*, 151 U.S. 186, 207 (1894).

48. *Id.*

49. 210 U.S. 405 (1908).

50. *Id.* at 415.

51. *Id.* at 414.

52. *See, e.g., Sanitary Refrigerator Co. v. Winters*, 280 U.S. 30, 39–40 (1929) (applying the doctrine of equivalents to find infringement of a patent that, while “not a pioneer patent entitled to a broad range of equivalents,” was nonetheless “meritorious and soon attained a large measure of commercial success”).

53. 339 U.S. 605 (1950).

54. *Id.* at 608 (“The doctrine [of equivalents] operates not only in favor of the patentee of a pioneer or primary invention, but also for the patentee of a secondary invention consisting of a combination of old ingredients which produce new and useful results.” (citing *Imhaeuser v. Buerk*, 101 U.S. 647, 655 (1879))).

insubstantial changes and substitutions in the patent” could make any patent right “a hollow and useless thing.”⁵⁵

Though the doctrine of equivalents was now more inclusive than ever, singling out pioneer patents remained an important part of infringement analysis for the next four decades. No longer required to determine which patents were eligible for the doctrine of equivalents, courts retooled the pioneer doctrine for use in determining just how far they should stretch to find infringement by equivalents. In the framework that developed, courts categorized litigated patents as “pioneers” or “improvements” and applied the doctrine of equivalents liberally to the former and narrowly to the latter.⁵⁶ Courts used this test as a matter of course until the late 1980s, routinely extending broad claim scope to a diverse collection of pioneer patents.⁵⁷

In 1982, Congress created the Court of Appeals for the Federal Circuit and conferred upon it jurisdiction to hear all appeals raising a substantial question of patent law.⁵⁸ Since that time, the Supreme Court has largely eschewed patent cases, leaving the development of patent law to the Federal Circuit.⁵⁹

55. *Id.* at 607.

56. *See, e.g.,* *Thomas & Betts Corp. v. Litton Sys., Inc.*, 720 F.2d 1572, 1580 (Fed. Cir. 1983) (“[W]hile a pioneer invention is entitled to a broad range application of the doctrine of equivalents, an invention representing only a modest advance over the prior art is given a more restricted (narrower range) application of the doctrine.”). Rather than setting forth the pioneer/non-pioneer distinction as a binary one, some courts have suggested that all patents should be afforded an intermediate range of equivalents determined by their importance, with “pioneers” and “mere improvements” demarcating the end-points of that continuum. *See Hughes Aircraft Co. v. United States*, 717 F.2d 1351, 1362 (Fed. Cir. 1983); *Cont’l Oil Co. v. Cole*, 634 F.2d 188, 198 n.7 (5th Cir. 1981); *Price v. Lake Sales Supply R.M., Inc.*, 510 F.2d 388, 394 (10th Cir. 1974).

57. *See, e.g.,* *Shields v. Halliburton Co.*, 667 F.2d 1232, 1238 (5th Cir. 1982) (a method of grouting the legs of offshore oil drilling platforms); *Swanson v. Unarco Indus., Inc.*, 479 F.2d 664, 669 (10th Cir. 1973) (a shopping cart design); *Corning Glass Works v. Anchor Hocking Glass Corp.*, 374 F.2d 473, 476 (3d Cir. 1967) (a method for crystallizing glass into a ceramic material); *Kori Corp. v. Wilco Marsh Buggies & Draglines, Inc.*, 561 F. Supp. 512, 522 (E.D. La. 1981) (an amphibious marsh craft); *Ronson Corp. v. Maruman of Cal., Inc.*, 224 F. Supp. 479, 481 (S.D. Cal. 1963) (a gas-fueled cigar lighter).

58. *See* Federal Courts Improvement Act of 1982, Pub. L. No. 97-164, § 127, 96 Stat. 25, 37–39 (codified as amended at 28 U.S.C.A. §§ 1295–1296 (West 2006 & Supp. 2011)).

59. *See* John F. Duffy, *The Festo Decision and the Return of the Supreme Court to the Bar of Patents*, 2002 SUP. CT. REV. 273, 275–77 (2002) (observing that the Supreme Court’s interest in patent law began to wane in the mid-twentieth century and that its “withdrawal from the field . . . bec[a]me even more complete aftrer [sic] the creation in 1982 of . . . the Federal Circuit”); Mark D. Janis, *Patent Law in the Age of the Invisible Supreme Court*, 2001 U. ILL. L. REV. 387, 387 (2001) (“The Court of Appeals for the Federal Circuit, created in 1982, has become the de facto supreme court of patents.”). In recent years, however, the Supreme Court has begun to reverse this trend. *See, e.g.,* *Bilski*

Within just a few years of its creation, the Federal Circuit dealt a blow to the pioneer doctrine that many believe left the doctrine mortally wounded. In *Texas Instruments, Inc. v. United States International Trade Commission*,⁶⁰ a three-judge panel of the Federal Circuit held—seemingly in contradiction of two centuries of case law—that a patent’s “‘pioneer’ status does not change the way infringement is determined.”⁶¹ Writing for the panel, Judge Newman reiterated the court’s holding two years prior that Texas Instruments’ handheld calculator patent was a “pioneer,”⁶² but went on to hold that

[t]here is not a discontinuous transition from “mere improvement” to “pioneer” The judicially “liberal” view of both claim interpretation and equivalency accorded a “pioneer” invention is not a manifestation of a different legal standard based on an abstract legal concept denominated “pioneer”. Rather, the “liberal” view flows directly from the relative sparseness of prior art in nascent fields of technology.⁶³

In the wake of *Texas Instruments*, the pioneer doctrine’s importance plummeted as patentees and courts increasingly began to view the doctrine as irrelevant. In less than a year, the pioneer doctrine had transitioned from patent law staple to “ancient jurisprudence.”⁶⁴ Seemingly, the doctrine’s long run was over. If any doubts remained, the Federal Circuit appeared to erase them in 1995 when, sitting en banc, the court applied the doctrine of equivalents in *Hilton Davis Chemical Co. v. Warner-Jenkinson Co.*⁶⁵ without mentioning the pioneer doctrine once.⁶⁶

C. Reports of the Pioneer Doctrine’s Death Are Greatly Exaggerated

Understandably, most believe that the pioneer doctrine’s story ends here. For almost two decades scholars have steadfastly reported that the pioneer doctrine is no more: that the doctrine “has fallen into

v. Kappos, 130 S. Ct. 3218, 3223 (2010); *KSR Int’l Co. v. Teleflex, Inc.*, 550 U.S. 398, 407 (2007); *eBay Inc. v. MercExchange, L.L.C.*, 547 U.S. 388, 390 (2006).

60. 846 F.2d 1369 (Fed. Cir. 1988).

61. *Id.* at 1370.

62. *Texas Instruments, Inc. v. U.S. Int’l Trade Comm’n*, 805 F.2d 1558, 1569 (Fed. Cir. 1986) (agreeing with *Texas Instruments* that its calculator was “a dramatic advance deserving pioneer status”).

63. *Texas Instruments*, 846 F.2d at 1370 (citation omitted).

64. *Sun Studs, Inc. v. ATA Equip. Leasing, Inc.*, 872 F.2d 978, 987 (Fed. Cir. 1989).

65. 62 F.3d 1512 (Fed. Cir. 1995) (en banc) (per curiam), *rev’d*, 520 U.S. 17 (1997).

66. *See id.* at 1514–29. As discussed in *infra* note 74, several members of the court did mention the doctrine in separate dissenting opinions.

relative obscurity,”⁶⁷ been “de-emphasized,”⁶⁸ or is “moribund”⁶⁹ and “no longer part of infringement analysis.”⁷⁰ Pointing to *Texas Instruments*, a handful of cases reiterating that holding,⁷¹ and the Federal Circuit’s opinion in *Hilton Davis*,⁷² these scholars have written off the pioneer doctrine as a relic of the past and have sought to examine it only as dead letter that perhaps ought to be brought back from the doctrinal hereafter.⁷³

But, scholarly consensus can be wrong. Despite oft-repeated assurances of its irrelevance, the pioneer doctrine quietly survived *Texas Instruments* and *Hilton Davis*. Now, more than twenty years later, the doctrine remains good law in many courtrooms across the nation and, indeed, may be well positioned for a return to prominence.

As an initial matter, case law supporting the pioneer doctrine has never been overruled. To the contrary, the Supreme Court has

67. Ted Baker, Note, *Pioneers in Technology: A Proposed System for Classifying and Rewarding Extraordinary Inventions*, 45 ARIZ. L. REV. 445, 445 (2003).

68. *Id.* at 450; see also Mills, *supra* note 9, at 657 (“Recent decisions analyzing the doctrine of equivalents, however, have de-emphasized the differences between pioneer and non-pioneer patents in determining the scope of equivalents.”).

69. Burk & Lemley, *Policy Levers*, *supra* note 9, at 1656.

70. Esther Steinhauer, Note, *Using the Doctrine of Equivalents to Provide Broad Protection for Pioneer Patents: Limited Protection for Improvement Patents*, 12 PACE L. REV. 491, 508 (1992).

71. See *Sun Studs, Inc. v. ATA Equip. Leasing, Inc.*, 872 F.2d 978, 987 (Fed. Cir. 1989) (“[T]he ‘pioneer’ is not a separate class of invention, carrying a unique body of law.”); *Corning Glass Works v. Sumitomo Elec. U.S.A., Inc.*, 868 F.2d 1251, 1261 n.7 (Fed. Cir. 1989); *In re Certain Doxorubicin and Preparations Containing the Same*, Inv. No. 337-TA-300, 20 U.S.P.Q.2d 1602, 1608 (May 2, 1991) (Final).

72. 62 F.3d 1512 (Fed. Cir. 1995) (en banc) (per curiam), *rev’d*, 520 U.S. 17 (1997).

73. See Burk & Lemley, *Biotechnology*, *supra* note 9, at 738 (calling for the pioneer doctrine to be “rejuvenat[ed]”); Burk & Lemley, *supra* note 39, at 1796–97 (“Courts should think expressly about the importance of an invention in defining its scope The now-moribund ‘pioneering patents’ doctrine could serve this purpose.”); Burk & Lemley, *Policy Levers*, *supra* note 9, at 1683 (same); Mark A. Lemley, *The Economics of Improvement in Intellectual Property Law*, 75 TEX. L. REV. 989, 1072–73 (1997) (“The Federal Circuit cast doubt on the status of the doctrine in its 1995 en banc decision in *Hilton Davis*, which reformulated the doctrine of equivalents in a way that did not include the pioneer status of the invention.”); Mills, *supra* note 9, at 653, 657 (observing that “[r]ecent decisions analyzing the doctrine of equivalents . . . have either excluded any analysis of whether a patent is a pioneer or have de-emphasized the differences between pioneer and non-pioneer patents” even though “the need for the doctrine of equivalents has increased, rather than decreased” in recent decades); Baker, *supra* note 67, at 445–46 (observing that the pioneer doctrine “has fallen into relative obscurity” and proposing that the doctrine be reformed to “increase damages for the infringement of . . . meritorious patents”); Steinhauer, *supra* note 70, at 508, 521–22 (observing that the pioneer doctrine is “no longer part of the infringement analysis” and proposing reforms that would reintroduce the distinction between “pioneers and improvements”).

consistently upheld the pioneer doctrine and discussed it favorably as recently as 1997. While it is true—as scholars have emphasized—that the Federal Circuit failed to address the pioneer doctrine in *Hilton Davis*,⁷⁴ the Supreme Court reversed that decision in an opinion that specifically mentioned on-going “judicial recognition of so-called ‘pioneer’ patents.”⁷⁵ Purely as a matter of binding authority, therefore, it is not at all clear that the Federal Circuit was free to ignore two centuries of precedent supporting the pioneer doctrine in *Texas Instruments*.⁷⁶

Moreover, since *Texas Instruments*, the Federal Circuit has hardly taken a consistent stance against the pioneer doctrine. Though the Federal Circuit last recognized a pioneer patent in 1988, the court has addressed the pioneer doctrine several times in the intervening years and has seldom chosen to follow its holding in *Texas Instruments*. In a number of cases, the court has reaffirmed longstanding precedent favoring pioneers. As recently as 2008, the Federal Circuit noted in *Cohesive Technologies, Inc. v. Waters Corp.*⁷⁷

74. 62 F.3d 1512, 1514–29 (Fed. Cir. 1995) (en banc) (per curiam), *rev'd*, 520 U.S. 17 (1997). Two dissenting opinions did reference the pioneer doctrine. *See id.* at 1549 (Lourie, J., dissenting) (“The pioneer status of the invention, not mentioned by the majority, . . . should be part of the [doctrine of equivalents] analysis.”); *id.* at 1568, 1571–72, 1577 (Nies, J., dissenting) (referring to the pioneer patent doctrine while setting forth the history of the doctrine of equivalents).

75. *Warner-Jenkinson Co. v. Hilton Davis Chem. Co.*, 520 U.S. 17, 27 n.4 (1997).

76. Because the Supreme Court’s forays into patent law are few and far between, Federal Circuit precedent often drifts away from prior Supreme Court holdings over time. When these precedential gulfs arise, the Supreme Court has been known to overturn decades of Federal Circuit law. *See* Rebecca S. Eisenberg, Commentary, *The Supreme Court and the Federal Circuit: Visitation and Custody of Patent Law*, 106 MICH. L. REV. FIRST IMPRESSIONS 28, 29 (2007), available at <http://www.michiganlawreview.org/assets/first/106/eisenberg.pdf> (noting that in recent years “the Supreme Court has granted certiorari when it believes the Federal Circuit has departed from the Supreme Court’s own patent law decisions” even when those decisions were “quite old” and of “limit[ed] . . . value”). For example, when the Supreme Court recently reviewed the nonobviousness standard in *KSR International Co. v. Teleflex, Inc.*, 550 U.S. 398 (2007), the Court “dusted off its own venerable case law for guiding principles, largely ignoring twenty-five years of more recent Federal Circuit decisions.” Eisenberg, *supra*, at 30 (noting that the Court’s holding “relied primarily on six of its own prior opinions” issued between 1851 and 1976 and “did not use any Federal Circuit decisions as authority for identifying or explaining the errors made by the Federal Circuit”). Even more recently in *Bilski v. Kappos*, 130 S. Ct. 3218 (2010), the Court blithely cast aside decades of Federal Circuit jurisprudence on the patentability of business methods. *See id.* at 3231 (“[N]othing in today’s opinion should be read as endorsing interpretations of [35 U.S.C.] § 101 that the Court of Appeals for the Federal Circuit has used in the past.”); *see also* ROBIN FELDMAN, RETHINKING PATENT LAW (forthcoming 2012) (manuscript at 9) (on file with the North Carolina Law Review) (noting that the Supreme Court’s *Bilski* opinion “disagreed with just about everything . . . the Federal Circuit had said in this arena”).

77. 543 F.3d 1351 (Fed. Cir. 2008).

that past precedent “emphasized that pioneering inventions often . . . result in broader application of the doctrine of equivalents.”⁷⁸ More importantly, the court has taken pioneer status into account a number of times when applying the doctrine of equivalents. In *Hoganas AB v. Dresser Industries, Inc.*,⁷⁹ for example, the court held that the patent-in-suit was not infringed under the doctrine of equivalents in part because “[the patented] invention is only a modest advance over [the prior art], and thus is not entitled to pioneering status or the broad range of equivalents which normally accompanies that status.”⁸⁰

Indeed, empirical evidence demonstrates the patent bar’s faith in the pioneer doctrine’s continued vitality. Between 2001 and 2010, no fewer than sixteen patentees asserted on appeal to the Federal Circuit that a patent-in-suit was a “pioneer” worthy of broad claim

78. *Id.* at 1371; *see also* *Molten Metal Equip. Innovations, Inc. v. Metallurgical Sys. Co.*, 56 F. App’x 475, 480 (Fed. Cir. 2003) (non-precedential opinion per FED. CIR. R. 32.1) (approving a jury instruction stating that “a pioneering invention . . . [is] entitled to a broad or liberal range of equivalents”); *Abbott Labs. v. Dey, L.P.*, 287 F.3d 1097, 1105 (Fed. Cir. 2002); *Ad-In-Hole, Int’l, Inc. v. Hageman*, No. 96-1455, 1997 WL 154003, at *2 (Fed. Cir. Apr. 2, 1997) (non-precedential opinion per FED. CIR. R. 32.1) (noting that “a pioneer invention is allowed a broader range of equivalents”); *Rite-Hite Corp. v. Kelley Co.* 56 F.3d 1538, 1554–55 (Fed. Cir. 1995) (en banc) (affirming a reasonable royalty based in part on the fact that the patent-in-suit was a “pioneer”); *Intel Corp. v. U.S. Int’l Trade Comm’n*, 946 F.2d 821, 842 (Fed. Cir. 1991) (“In applying the doctrine of equivalents, the fact finder must determine the range of equivalents . . . in light of the . . . pioneer-nonpioneer status of the invention . . .” (quoting *D.M.I., Inc. v. Deere & Co.*, 755 F.2d 1570, 1575 (Fed. Cir. 1985))).

Also, a number of judges have individually supported the doctrine when writing separate opinions. *See Enzo Biochem, Inc. v. Gen-Probe, Inc.*, 323 F.3d 956, 982 (Fed. Cir. 2002) (Rader, J., dissenting from denial of rehearing en banc) (noting the need to “demarc[] the boundary between pioneer inventions and patentable improvements”); *Hilton Davis*, 62 F.3d at 1549 (Lourie, J., dissenting) (“The pioneer status of the invention . . . should be part of the [doctrine of equivalents] analysis. . . . Pioneers should be given more scope of protection than inventors in a crowded art.”); *Balt. Therapeutic Equip. Co. v. Loredan Biomedical, Inc.*, Nos. 93-1301, 93-1331, 1994 WL 124022, at *6 (Fed. Cir. Apr. 12, 1994) (non-precedential opinion per FED. CIR. R. 32.1) (Rich, J., concurring) (“How far beyond what is disclosed a court may expand . . . is . . . dependent on various factors . . . [including the] pioneer status of the invention as a whole”); *Int’l Visual Corp. v. Crown Metal Mfg. Co.*, 991 F.2d 768, 775 (Fed. Cir. 1993) (Lourie, J. concurring) (“Whether a patent claims a pioneering invention may be a factor favoring the application of the doctrine [of equivalents].”); *Atl. Thermoplastics Co., Inc. v. Faytex Corp.*, 974 F.2d 1299, 1301 (Fed. Cir. 1992) (Rader, J., concurring in denial of rehearing en banc) (considering patentee’s claim to a pioneering method in concluding that patentee did not intend to limit the scope of its claim).

79. 9 F.3d 948 (Fed. Cir. 1993).

80. *Id.* at 954; *see also* *Petrosky v. Nike, Inc.*, No. 91-1513, 1992 WL 78089, at *1 (Fed. Cir. Apr. 21, 1992) (non-precedential opinion per FED. CIR. R. 32.1) (rejecting the patentee’s claim of pioneer status); *Extrel FTMS, Inc. v. Bruker Instruments, Inc.*, Nos. 91-1216, 91-1222, 1992 WL 9869, at *3 (Fed. Cir. Jan. 24, 1992) (non-precedential opinion per FED. CIR. R. 32.1) (same).

scope⁸¹—a figure comparable to the number who have asked the court to consider such hotly debated topics as the reverse doctrine of

81. Opening Brief of Plaintiffs-Appellants ERBE Elektromedizin GmbH & ERBE USA, Inc. at 40, *ERBE Elektromedizin GmbH v. Canady Tech. LLC*, 629 F.3d 1278 (Fed. Cir. 2010) (Nos. 2008-1425, 2008-1426), 2008 WL 4307426 (arguing that “one of skill in the art” would read more broadly “the claims of a pioneering patent such as the [patent-in-suit]”); Corrected Brief for Plaintiff-Appellant at 39, *Cordis Corp. v. Medtronic AVE, Inc.*, 511 F.3d 1157 (Fed. Cir. 2008) (Nos. 02-1457, 02-1458, 02-1481, 02-1482), 2002 WL 32815095, at *39; Brief of Plaintiffs-Appellants the Regents of the University of California, Abbott Molecular Inc. & Abbott Laboratories Inc. at 44, *Regents of the Univ. of Cal. v. Dako A/S, Inc.*, 517 F.3d 1364 (Fed. Cir. May 11, 2007) (No. 2007-1202), 2007 WL 1573997 (arguing that the patentee was “allowed broad claims” because of “the pioneering invention first described by the [patents-in-suit]”); Brief of Appellant at 21, *Automed Techs., Inc. v. Knapp Logistics & Automation, Inc.*, 236 F. App’x 604 (Fed. Cir. 2007) (per curiam) (non-precedential opinion per FED CIR. R. 32.1) (No. 06-1587), 2006 WL 3420475 (“When the patent, as in this case, discloses a unique invention that breaks new scientific ground—a so-called ‘pioneer patent’—the patentee enjoys the benefit of broader claims”); Opening Brief of Plaintiff-Appellant Monster Cable Products, Inc. at 51–54, *Monster Cable Prods., Inc. v. Quest Grp.*, 210 F. App’x 993 (Fed. Cir. 2006) (non-precedential disposition per FED CIR. R. 32.1) (Nos. 06-1111, 06-1112), 2006 WL 1287721 (arguing that the district court erred, by “its misunderstanding of pioneer status,” in denying the patent-in-suit “a pioneer’s scope of equivalents”); Corrected Non-Confidential Brief of Plaintiff-Appellant Tritex Technologies, Inc. at 1, 14, *Tritex Techs., Inc. v. United States*, 208 F. App’x 869 (Fed. Cir. 2006) (non-precedential disposition per FED CIR. R. 32.1) (No. 06-5014), 2006 WL 951953; Brief of Plaintiff/Counterclaim Defendant-Appellant Kwik Products, Inc. & Counterclaim Defendants-Appellees Fernando R. Iacona and Ignazio M. Iacona at 40–41, *Kwik Prods., Inc. v. Nat’l Express, Inc.*, 179 F. App’x 34 (Fed. Cir. 2006) (non-precedential disposition per FED CIR. R. 32.1) (Nos. 05-1319, 05-1343), 2005 WL 1649349, at *40–41; Brief of Plaintiff-Appellant Arlaine & Gina Rockey, Inc. at 12, *Arlaine & Gina Rockey, Inc. v. Cordis Corp.*, 175 F. App’x 329 (Fed. Cir. 2006) (non-precedential opinion per FED CIR. R. 32.1) (No. 05-1236), 2005 WL 1178098, at *12; Brief and Addendum of Appellant Duane L. Knopik at 50 n.16, *Knopik v. BP Prods. N. Am., Inc.*, 95 F. App’x 332 (Fed. Cir. 2004) (per curiam) (non-precedential opinion per FED CIR. R. 32.1) (Nos. 03-1420, 03-1446), 2003 WL 24028400, at *50 n.16; Brief of Appellant Pieczenik at 4, *Pieczenik v. Dyax Corp.*, 76 F. App’x 293 (Fed. Cir. 2003) (non-precedential opinion per FED CIR. R. 32.1) (No. 03-1302); Brief of Plaintiffs-Appellants ACTV, Inc. & Hypertv Networks, Inc. at 52, 59, 62, *ACTV, Inc. v. Walt Disney Co.*, 346 F.3d 1082 (Fed. Cir. 2003) (No. 02-1491), 2002 WL 32815102, at *52, *59, *62; Replacement Brief for Plaintiff-Appellant at 58, *Lopes v. Hardware Distrib., Ltd.*, 67 F. App’x 604 (Fed. Cir. 2003) (non-precedential opinion per FED CIR. R. 32.1) (No. 02-1146), 2002 WL 32615445, at *58; Brief for Plaintiff-Cross Appellant Boehringer Ingelheim Vetmedica, Inc. (Nonconfidential) at 58, *Boehringer Ingelheim Vetmedica, Inc. v. Schering-Plough Corp.*, 320 F.3d 1339 (Fed. Cir. 2003) (Nos. 02-1026, 02-1027), 2002 WL 32620050; Corrected Principal Brief of Plaintiffs-Appellees Laporte Pigments, Inc. & Chemische Werke Brockhües AG at 69, *LaPorte Pigments, Inc. v. Axel J., L.P.*, 44 F. App’x 960 (Fed. Cir. 2003) (non-precedential opinion per FED CIR. R. 32.1) (Nos. 01-1226, 01-1227), 2002 WL 32619974, at *69; Brief for Plaintiff-Appellant at 23–30, *Plant Genetic Sys., N.V. v. DeKalb Genetics Corp.*, 315 F.3d 1335 (Fed. Cir. 2003) (No. 02-1011), 2001 WL 34629700, at *23–30; Appellant’s Reply Brief Non-Confidential Version at 14, *Leggett & Platt, Inc. v. Hickory Springs Mfg. Co.*, 285 F.3d 1353 (Fed. Cir. 2002) (No. 01-1255), 2001 WL 34373107, at *14; *cf.* Brief of Amicus Curiae the Ass’n for Competitive Technology in Support of Plaintiff-Appellee in Favor of Affirmance at 20, *TiVo, Inc. v.*

equivalents,⁸² the scope of patentable subject matter,⁸³ and the entire market value rule.⁸⁴ In more than forty other appeals during the same time period, patentees have characterized their patents as “pioneers” for (at least) the rhetorical support that label provides.⁸⁵

EchoStar Corp., 98 U.S.P.Q.2d 1852 (Fed. Cir. 2011) (non-precedential opinion per FED CIR. R. 32.1) (No. 09-1374), 2010 WL 3950032, at *20 (“It is a venerable principle of patent law that pioneering patents—important patents that open up a new field—should be entitled to a broader range of protection than more modest inventions or improvements on existing ideas.” (quoting Burk & Lemley, *Policy Levers*, *supra* note 9, at 1656) (internal quotation marks omitted)); Brief for Appellee at 57, *Symbol Techs., Inc. v. Lemelson Med., Educ., & Research Found., L.P.*, 429 F.3d 1051 (Fed. Cir. 2005) (No. 00-1583), 2001 WL 34607706 (“A pioneer inventor such as Mr. Lemelson, especially, may not fully appreciate the extent of the inventions his disclosure entitles him to claim.”); Brief of Plaintiff-Appellee Unique Coupons, Inc. at 7, *Unique Coupons, Inc. v. Northfield Corp.*, 38 F. App’x 578 (Fed. Cir. 2002) (non-precedential disposition per FED CIR. R. 32.1) (No. 01-1425), 2001 WL 36089076, at *7 (“To the contrary—as the district court held—Unique’s inventions were pioneering and broad.”).

In many other cases, accused infringers have relied on the pioneer doctrine to argue that patentees’ inventions are mere improvements entitled to few, if any, equivalents. *See, e.g.*, Corrected Response Brief of Defendant-Appellee at 64–65, *Tofasco of Am., Inc. v. Atico Int’l U.S.A., Inc.*, 2011 WL 2631818 (Fed. Cir. 2011) (non-precedential disposition per FED CIR. R. 32.1) (No. 2010-1208), 2010 WL 3048413, at *64–65; Reply Brief of Appellant at 37, *Mitutoyo Corp. v. Central Purchasing, L.L.C.*, 499 F.3d 1284 (Fed. Cir. 2007) (Nos. 2006-1312, 2006-1343), 2007 WL 649187; Brief for Appellees Dey, L.P. & Dey, Inc. at 21, *Abbott Labs. v. Dey, L.P.*, 287 F.3d 1097 (Fed. Cir. 2002) (No. 01-1374), 2001 WL 34148341.

82. Parties in fourteen appeals raised the reverse doctrine of equivalents between 2001 and 2010. For a list of citations, see Appendix A in Brian J. Love, *Appendices for Interring the Pioneer Doctrine*, 1 (Jan. 2, 2012), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1963946. Under the so-called reverse doctrine of equivalents, courts may permit a particularly important improvement invention to escape an infringement claim even though it falls within the literal scope of existing patent rights. *See Westinghouse v. Boyden Power Brake Co.*, 170 U.S. 537, 568 (1898) (“The converse [of the doctrine of equivalents] is equally true. The patentee may bring the defendant within the letter of his claims, but if the latter has so far changed the principle of the device that the claims of the patent, literally construed, have ceased to represent his actual invention, he is as little subject to be adjudged an infringer as one who has violated the letter of a statute has to be convicted, when he has done nothing in conflict with its spirit and intent.”).

83. Parties (or amici) in just twelve appeals raised 35 U.S.C. § 101 as a defense between 2001 and the time *In re Bilski*, 545 F.3d 943 (2008), reached the Federal Circuit in early 2007. For a list of citations, see Appendix B in Brian J. Love, *Appendices for Interring the Pioneer Doctrine*, 2 (Jan. 2, 2012), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1963946. Patentable subject matter has been raised in about twenty cases post-*Bilski*. A complete list is on file with the North Carolina Law Review.

84. Parties in just over thirty appeals raised the entire market value rule between 2001 and 2010. A complete list is on file with the North Carolina Law Review. The entire market value rule allows the patentee of a component invention to recover damages based on the entire value of a complex infringing product incorporating that component. *See* Brian J. Love, Note, *Patentee Overcompensation and the Entire Market Value Rule*, 60 STAN. L. REV. 263, 264 (2007).

85. For a list of citations, see Appendix C in Brian J. Love, *Appendices for Interring the Pioneer Doctrine*, 2–5 (Jan. 2, 2012), <http://papers.ssrn.com/sol3/papers.cfm?abstract>

Lower courts have been even more receptive to patentees' requests for recognition as "pioneers." Since *Texas Instruments*, at least twelve district courts have applied the doctrine of equivalents more liberally to patents based on their pioneering nature.⁸⁶ Several

_id=1963946. Moreover, in a testament to the doctrine's perceived power, even a passing reference to the "pioneering" nature of the invention-at-issue will frequently drive an accused infringer to respond, rather than assume the doctrine is moribund. See, e.g., Brief of Defendants-Cross Appellants Becton, Dickinson & Co. & Nova Biomedical Corp. at 6, *Therasense, Inc. v. Becton, Dickinson & Co.*, 99 U.S.P.Q.2d 1065 (Fed. Cir. 2011) (Nos. 09-1008, 09-1009, 09-1010, 09-1034, 09-1035, 09-1036, 09-1037), 2009 WL 1208037; Non-Confidential Brief for Plaintiff-Appellee Intervet Inc. at 3, *Intervet Inc. v. Merial Ltd.*, 617 F.3d 1282 (Fed. Cir. 2010) (No. 2009-1568), 2010 WL 783528, at *3 ("Merial seeks to broaden its patent disclosure by portraying the [patent-in-suit] as 'pioneering' But in truth there is nothing pioneering about [it].").

86. *Ajinomoto Co. v. Archer-Daniels-Midland Co.*, No. 95-218-SLR, 1998 WL 151411, at *44 (D. Del. Mar. 13, 1998) ("Given the novel nature of the claimed invention, the . . . patent deserves pioneer patent status."), *aff'd*, 228 F.3d 1338 (Fed. Cir. 2000); *Weatherchem Corp. v. J.L. Clark, Inc.*, 937 F. Supp. 1262, 1292 (N.D. Ohio 1996) (holding that the invention "disclosed by the [patent-in-suit] was a pioneer invention . . . , and is thus entitled to a broad and liberal application of the doctrine of equivalents" (citation omitted)), *aff'd in part, modified in part, vacated in part*, 163 F.3d 1326 (Fed. Cir. 2000); *Novo Nordisk of N. Am. v. Genentech*, No. 94 Civ. 8634 (CBM), 1995 WL 512171, at *12 (S.D.N.Y. June 28, 1995) ("[T]he [patent-in-suit] represents a pioneering contribution . . . [and] [a]s such . . . is entitled to a broad construction . . ."), *vacated*, 77 F.3d 1364 (Fed. Cir. 1996); *Pfizer Inc. v. F & S Alloys & Minerals Corp.*, 856 F. Supp. 808, 815 (S.D.N.Y. 1994); *Saes Getters, S.p.A. v. Ergenics, Inc.*, 816 F. Supp. 979, 985 (D.N.J. 1992), *aff'd*, 989 F.2d 1201 (Fed. Cir. 1993); *B.F. Goodrich FlightSystems, Inc. v. Insight Instruments Corp.*, No. C-2-91-0800, 1992 WL 193112, at *14 (S.D. Ohio Feb. 25, 1992), *aff'd*, 991 F.2d 810 (Fed. Cir. 1993); *T.A. Pelsue Co. v. Grand Enters., Inc.*, 782 F. Supp. 1476, 1495 (D. Colo. 1991); *Stranco, Inc. v. Atlantes Chem. Sys., Inc.*, No. Civ.A. H-86-26, 1990 WL 10072072, at *3 (S.D. Tex. May 31, 1990), *aff'd*, 960 F.2d 156 (Fed. Cir. 1992); *Read Corp. v. Portec, Inc.*, 748 F. Supp. 1078, 1095 (D. Del. 1990), *aff'd in part, rev'd in part*, 970 F.2d 816 (Fed. Cir. 1992); *Loral Corp. v. B.F. Goodrich Co.*, No. C-3-86-216, 1989 WL 206377, at *8 (S.D. Ohio 1989), *rev'd*, 899 F.2d 1228 (Fed. Cir. 1990); *Insta-Foam Prods., Inc. v. Universal Foam Sys., Inc.*, No. 83-C-1952, 1988 U.S. Dist. LEXIS 17582, at *16 (E.D. Wis. Aug. 19, 1988); *de Graffenried v. United States*, 20 Cl. Ct. 458, 485 (Cl. Ct. 1990).

Several other courts have ruled that a patent is a "pioneer" and used this determination for another purpose. See *WMS Gaming v. Int'l Game Tech.*, No. 94-C-3062, 1996 U.S. Dist. LEXIS 13864, at *6, *45-46 (N.D. Ill. Sept. 20, 1996) (declaring the patent-in-suit "a highly successful, pioneer patent" and suggesting this fact weighed against a finding of obviousness); cf. *Ecolab, Inc. v. Paraclipse, Inc.*, No. 8:97CV304, 2008 WL 5100730, at *1 (D. Neb. Nov. 26, 2008) (including in a "Joint Stipulation for Entry of Final Judgment" that "[t]he invention of the [patent-in-suit] is a pioneering invention"); *Transco Prods. Inc. v. Performance Contracting, Inc.*, 813 F. Supp. 613, 621 (N.D. Ill. 1993) (assuming for purposes of ruling on an accused infringer's motion for summary judgment of noninfringement that the patent-in-suit was a pioneer); *Pall Corp. v. Micron Separations, Inc.*, 792 F. Supp. 1298, 1312 (D. Mass. 1992) (noting, but not expressly relying upon, the fact that the patents-in-suit were "pioneers"), *aff'd in part, modified in part, rev'd in part*, 66 F.3d 1211 (Fed. Cir. 1995); *Otto Zollinger, Inc. v. Qualitex, Inc.*, No. 84-1630, 1989 U.S. Dist. LEXIS 372, at *4 (E.D. Pa. Jan. 17, 1989) (same); *infra* notes 95-97 (collecting cases where courts have noted whether a patent is a pioneer in assessing

dozen others have applied the doctrine, but ruled that the patent-in-suit is not a pioneer.⁸⁷ And in dozens more cases, courts have acknowledged the pioneer doctrine, but declined to reach it by ruling on other grounds.⁸⁸

These empirical findings show that, contrary to conventional wisdom in the patent literature, many jurists and attorneys in the patent bar believe that the pioneer doctrine is alive and well. Indeed, these findings likely understate the extent to which the pioneer doctrine remains a viable part of the doctrine of equivalents in four ways. First, empirical evidence suggests that courts find infringement by equivalents less frequently today than they ever have. In a recent study, John Allison and Mark Lemley found that patentees' overall win rate under the doctrine of equivalents has fallen significantly over the last two decades.⁸⁹

Second, there is good reason to believe that relative to prior eras there are simply fewer "pioneer" candidates among patents granted today. The number of patents issued each year has almost trebled

royalty damages, deciding whether to grant an injunction, and describing improvement patents).

87. For examples from the last decade see, e.g., *Uniloc USA, Inc. v. Microsoft Corp.*, C.A., No. 03-440 S, 2007 U.S. Dist. LEXIS 97491, at *20 n.8 (D.R.I. Oct. 19, 2007); *Linear Tech. Corp. v. Micrel, Inc.*, No. C-94-1633 MHP, 2006 U.S. Dist. LEXIS 96860, at *170-71 (N.D. Cal. June 9, 2006); *Chiron Corp. v. SourceCF Inc.*, 431 F. Supp. 2d 1019, 1034 (N.D. Cal. 2006); *Medtronic Navigation, Inc. v. Brainlab Medizinische Computersysteme GmbH*, 417 F. Supp. 2d 1188, 1199-1200 (D. Colo. 2006); *Monster Cable Prods., Inc. v. Quest Grp.*, No. C-04-0005 MHP, 2005 WL 1875466, at *8-9 (N.D. Cal. Aug. 8, 2005); *Pro-Tech Welding & Fabrication, Inc. v. Lajuett*, 367 F. Supp. 2d 398, 409-10 (W.D.N.Y. 2005); *Ghaly v. Hasbro, Inc.*, Nos. 97-CV-7037 (DRH), 98-CV-5239 (DRH), 2003 U.S. Dist. LEXIS 25980, at *43-45 (E.D.N.Y. 2003).

88. For examples from the last decade, see, e.g., *Regents of Univ. of Cal. v. Dako N. Am., Inc.*, No. C-05-03955 MHP, 2009 WL 1083446, at *11 n.5 (N.D. Cal. Apr. 22, 2009); *CNET Networks, Inc. v. Etilize, Inc.*, No. C 06-5378 MHP, 2008 U.S. Dist. LEXIS 66737, at *15 (N.D. Cal. Sept. 2, 2008); *Kenall Mfg. Co. v. Genlyte Thomas Grp. L.L.C.*, 413 F. Supp. 2d 937, 938 n.1 (N.D. Ill. 2006); *Halmar Robicon Grp., Inc. v. Toshiba Int'l Corp.*, No. 98-501, 2003 WL 25815131, at *4 n.5 (W.D. Pa. Dec. 17, 2003).

89. Allison & Lemley, *supra* note 27, at 963, 966, 978 (finding that prior to the Supreme Court's opinion in *Markman v. Westview Instruments, Inc.*, 517 U.S. 370 (1996), patentees won 40% of all motions and verdicts applying the doctrine of equivalents compared with just 21.7% between December 2000 and May 2002, and just 22.2% between February 2004 and August 2005); *see also id.* at 967 (finding that patentees proved infringement under the doctrine of equivalents in just 29 of 413 cases in which the issue was raised between May 1999 and August 2005); Joshua D. Sarnoff, *Abolishing the Doctrine of Equivalents and Claiming the Future After Festo*, 19 BERKELEY TECH. L.J. 1157, 1198 (2004) (finding that, in 2002, accused infringers won 123 of 145 reported cases reaching a final determination on infringement under the doctrine of equivalents).

over the last three decades,⁹⁰ and this growth has been especially concentrated in a number of fields, namely computing and complex electronics.⁹¹ This proliferation of patents naturally makes it less likely that any given patent will qualify as a pioneer. The relative complexity of modern technology may also make judges less willing to declare that patented technology they do not fully understand is “pioneering.”⁹²

Third, empirical results can never fully quantify the extent to which the concept of pioneer patents has influenced many other aspects of patent law. As the appellate briefs cited above demonstrate, patentees often seek to characterize their patents as “pioneers” for reasons that have little to do with extending patent scope under the doctrine of equivalents.⁹³ In recent years, self-proclaimed “pioneer” patentees have asked courts for special treatment in a number of patent law areas. In 2003, for example, the Federal Circuit considered but rejected the argument that pioneers should receive preferential treatment under the enablement requirement.⁹⁴ Such attempts have not always been unsuccessful. For example, a small, but significant line of precedent holds that pioneer

90. *U.S. Patent Statistics Chart Calendar Years 1963–2010*, U.S. PATENT & TRADEMARK OFFICE, http://www.uspto.gov/web/offices/ac/ido/oeip/taf/us_stat.htm (last modified Sept. 7, 2011) (reporting that the number of patents issued per year has increased from 61,819 in 1980 to 167,349 in 2009 to 219,614 in 2010). The number of patent applications filed each year has more than quadrupled since 1980. *See id.* (reporting that the number of utility patent applications filed per year increased from 104,329 in 1980 to 490,226 in 2010).

91. *See Allison & Lemley, supra* note 22, at 94 (observing that there was “a sea change in patenting” between the late 1970s and late 1990s during which “the trend has been towards patenting in industries considered ‘high-tech,’ such as software, semiconductors, computers, and biotechnology”).

92. *See Karen Feng, Note, Plant Genetic Systems v. DeKalb: The Pioneer Doctrine Cannot Substitute for Defective Enablement*, 45 JURIMETRICS J. 93, 102 (2004) (making a similar argument).

93. As one commentator has noted, even when courts do not rely on the doctrine, there is good reason to believe that judges familiar with it “consciously tip the balance in favor of infringement” when the patentee is arguably worthy of the title “pioneer.” *See Samson Vermont, A New Way to Determine Obviousness: Applying the Pioneer Doctrine to 35 U.S.C. § 103(a)*, 29 AIPLA Q.J. 375, 406 (2001).

94. *Plant Genetic Sys., N.V. v. DeKalb Genetics Corp.*, 315 F.3d 1335, 1339–42 (Fed. Cir. 2003). Pioneers have asked for preferential treatment in other cases as well. *See Cimiotti Unhairing Co. v. Am. Fur Ref. Co.*, 198 U.S. 399, 406 (1905) (suggesting that pioneer patents should receive liberal claim construction, in addition to liberal treatment under the doctrine of equivalents); *Pfaff v. Wells*, 124 F.3d 1429, 1435 (Fed. Cir. 1997) (rejecting patentee’s argument that courts “should afford greater latitude under the on-sale bar to an innovative, or pioneer, patent”).

patents are entitled to higher reasonable royalty damages.⁹⁵ Another lowers the bar pioneers must hurdle to obtain an injunction.⁹⁶ Further, over the years, the term “pioneer” has been imported into other areas of patent law to signify the dominant patent right among many. For example, courts and scholars discussing blocking patent rights generally refer to the senior and junior rightsholders as the “pioneer” and “improver,” respectively.⁹⁷ Courts reviewing challenges to Abbreviated New Drug Applications—which permit generic drug manufacturers to apply for FDA approval before name brand manufacturers’ patent rights expire—follow a similar convention, referring to the existing name-brand drug as the “pioneer.”⁹⁸

95. This case law is almost totally confined to the United States Court of Federal Claims. *See, e.g.,* Standard Mfg. Co. v. United States, 42 Fed. Cl. 748, 771 (Fed. Cl. 1999) (stopping short of characterizing the patent-at-suit as a “pioneer,” but recognizing the invention as “highly advantageous in comparison to [the prior art],” a finding that “favored an increase in the negotiated royalty rate” for the patentee); Brunswick Corp. v. United States, 36 Fed. Cl. 204, 212, 214 (Fed. Cl. 1996) (“The patent at issue is a pioneer patent, and therefore, there are no exactly comparable patent licenses and royalty rates from which to draw wisdom.”); Dow Chem. Co. v. United States, 36 Fed. Cl. 15, 26 (Fed. Cl. 1996), *rev’d*, 226 F.3d 1334 (Fed. Cir. 2000). Nonetheless, it has been applied by district courts and even implicitly approved by the Federal Circuit. *See* Rite-Hite Corp. v. Kelley Co., Inc., 56 F.3d 1538, 1554–55 (Fed. Cir. 1995) (affirming a reasonable royalty based in part on a finding below that the patent-in-suit was a “pioneer”).

96. *See* Emory Univ. v. Nova BioGenetics, Inc., No. 1:06-CV-0141-TWT, 2008 U.S. Dist. LEXIS 57642, at *12 (N.D. Ga. 2008) (“[W]here a company pioneers an invention in the marketplace, irreparable harm flows from a competitor’s attempts to usurp the pioneering company’s market position and goodwill.” (quoting 800 Adept., Inc. v. Murex Sec. Ltd., 505 F. Supp. 2d 1327, 1337 (M.D. Fla. 2007)) (internal quotation marks omitted)); *see also* Genentech, Inc. v. Novo Nordisk A/S, 935 F. Supp. 260, 285 (S.D.N.Y. 1996) (noting that the patent-in-suit covers a “pioneering invention” when granting the patentee’s request for a preliminary injunction); Voice Sys. & Servs. v. VMX, Inc., 26 U.S.P.Q.2d (BNA) 1106, 1107 (N.D. Okla. 1992) (making a similar finding).

97. *See, e.g.,* Prima Tek II, L.L.C. v. A-Roo Co., 222 F.3d 1372, 1379 n.2 (Fed. Cir. 2000) (“A ‘blocking patent’ is an earlier patent that must be licensed in order to practice a later patent. This often occurs, for instance, between a pioneer patent and an improvement patent.”); Robert Merges, *Intellectual Property Rights and Bargaining Breakdown: The Case of Blocking Patents*, 62 TENN. L. REV. 75, 79 (1994).

98. *See, e.g.,* Eli Lilly & Co. v. Medtronic, Inc., 496 U.S. 661, 676–77 (1990). One more example of preferential treatment for inventive “pioneers” comes from outside patent law. From 1991 to 1997, the FCC applied a “pioneer’s preference rule[]” to “extend[] preferential treatment in the FCC’s [wireless spectrum] licensing processes to parties that demonstrated their responsibility for developing new spectrum-using communications services and technologies.” *Pioneer’s Preference Program*, FCC OFF. OF ENG’G & TECH., <http://transition.fcc.gov/oet/faqs/pioneerfaqs.html> (last updated Jan. 13, 2000); *see also* In Matter of Establishment of Procedures to Provide a Preference to Applicants Proposing an Allocation for New Services, 6 F.C.C. Rcd. 3488, 3494 (1991) (discussing the pioneer preference).

Fourth, there is good reason to believe that the pioneer doctrine may soon rise to its former level of prominence. As described in greater detail below, since the pioneer doctrine was declared dead in the patent literature twenty years ago, a number of scholars have called for the doctrine's revival.⁹⁹ The most convincing calls for greater application of the pioneer doctrine have come from scholars arguing that a strong pioneer doctrine ought to be applied in the pharmaceutical and biomedical industries where new products require substantial investment and are long delayed in waiting for approval from the FDA.¹⁰⁰ If, as many predict, biotechnology replaces computer technology as the most visible and lucrative area of innovative growth in the twenty-first century,¹⁰¹ revolutionary breakthroughs in biomedicine may well rekindle patent law's interest in the pioneer doctrine.

II. FOR THE PIONEER DOCTRINE

In the literature, presumptions about the pioneer doctrine's irrelevance in modern patent litigation are invariably followed by arguments that the doctrine ought to be revived to remedy one of various perceived inefficiencies in the patent system. As discussed above, long-held beliefs about the pioneer doctrine's viability proved to be unfounded. The next two Parts examine the doctrine's benefits and conclude that the pioneer doctrine has no place in modern patent law. This part summarizes arguments supporting the pioneer doctrine.

Scholars calling for the doctrine's revival generally fall into one of three categories.¹⁰² One group argues that various aspects of the patent prosecution system tend to work against inventors of groundbreaking technology and deny them full protection. Michael Meurer and Craig Nard, for example, have argued that the pioneer doctrine ought to be applied to save pioneer inventors from high "refinement costs"—i.e., costs associated with "identifying and claiming the broadest patentable set of embodiments enabled by the disclosure in the patent specification"—namely "legal fees and the implicit cost of the effort of the inventor and others" to further

99. See *infra* notes 104–06 and accompanying text.

100. See *infra* note 106.

101. See *supra* note 8.

102. Courts, on the other hand, have largely been mum on the subject. Thomas, *supra* note 3, at 52 ("The courts have offered little justification for the application of the pioneer invention doctrine."); Vermont, *supra* note 93, at 403–05 ("The underlying purpose of the pioneer doctrine is a mystery that courts seldom attempt to solve.").

“refine [their] understanding of the invention.”¹⁰³ A second group argues that the pioneer doctrine increases overall innovation by encouraging inventors to tackle technological problems so risky that existing patent rights are an insufficient incentive. Samuel Oddi, for example, has proposed the creation of a sui generis “Revolutionary Patent” that would provide incontestable protection to “extraordinary” inventions for thirty-four years from the patent grant date as a means to spur growth of the U.S. economy.¹⁰⁴ Finally, a third group argues that extending broad patent rights to early inventors in nascent markets increases overall innovation by permitting pioneer firms to coordinate subsequent research and development (“R&D”).¹⁰⁵ Recently, this argument has been embraced by a number of scholars who believe that a rejuvenated pioneer doctrine might help clear the proliferation of patents currently hindering development in the biomedical industry.¹⁰⁶

103. Meurer & Nard, *supra* note 3, at 1952–55, 1989, 2004.

104. A. Samuel Oddi, *Beyond Obviousness: Invention in the Twenty-First Century*, 38 AM. U. L. REV. 1097, 1098–99, 1128–47 (1989). Oddi, of course, could not have foreseen at the time that just a few years later the U.S. economy would experience unprecedented growth due to an explosion in computer and internet technology, most of which was developed without reliance on patent protection. *See infra* notes 305–06 and accompanying text.

Numerous other commentators have written in support of reviving the pioneer doctrine. *See* Burk & Lemley, *supra* note 39, at 1796–97; Anthony Azure, Note, *Festo’s Effect on After-Arising Technology and the Doctrine of Equivalents*, 76 WASH. L. REV. 1153, 1181–82 (2001) (arguing that pioneer inventors receive unduly narrow claim scope under the modern doctrine of equivalents); Baker, *supra* note 67, at 445–46; Steinhauer, *supra* note 70, at 521–22 (arguing that the doctrine of equivalents should be applied to pioneer patents “as a whole” and to improvement patents on an “element by element” basis); *cf.* Harold C. Wegner, *Equitable Equivalents: Weighing the Equities to Determine Patent Infringement in Biotechnology and Other Emerging Technologies*, 18 RUTGERS COMPUTER & TECH. L.J. 1, 46–47 (1992) (proposing reforms to the doctrine of equivalents, including limiting “application of the doctrine . . . to situations of pioneer inventions or actual copying, as envisioned in the early trial opinions of Justices Story and Washington”).

105. As discussed in detail below, this line of argument is based on Edmund Kitch’s “prospect theory.” *See* Edmund W. Kitch, *The Nature and Function of the Patent System*, 20 J.L. & ECON. 265, 265–66 (1977).

106. *See* Burk & Lemley, *Biotechnology*, *supra* note 9, at 738 (suggesting that “rejuvenating the doctrine of pioneer patents” would help “minimize the anticommens problems and give inventors sufficient control to induce them to walk the uncertain path towards commercial development” in the biotechnology industry); Burk & Lemley, *Policy Levers*, *supra* note 9, at 1656, 1683 (same); *see also* Mills, *supra* note 9, at 653, 657 (suggesting that “[r]ecent decisions . . . de-emphasiz[ing] the differences between pioneer and non-pioneer patents” may hinder innovation because “the doctrine of equivalents may be the only viable means for bringing an infringement claim in certain areas of new technology, such as biotechnology”); Faith S. Fillman, Comment, *Doctrine of Equivalents: Is Festo the Right Decision for the Biomedical Industry?*, 33 ST. MARY’S L.J. 493, 529–30

A. Patent-Drafting Frictions

The first rationale for the pioneer invention doctrine closely tracks the modern justification for the doctrine of equivalents. According to this theory, various “frictions” in the patent prosecution system prevent patentees from receiving claims that literally cover the full scope of their inventions.¹⁰⁷ Among these frictions are (1) the inherent difficulty of describing a physical invention in words, (2) patentees’ inability to foresee how technology will develop after their patent issues, and (3) the possibility that in some instances patent examiners who lack inventors’ expertise in cutting-edge technology will unnecessarily restrict claim scope.¹⁰⁸ To supporters of the friction theory, the doctrine of equivalents exists to counteract these frictions and, thereby, to ensure that patentees are properly rewarded for their inventive contribution.¹⁰⁹ Courts and commentators have extended this line of argument to support the pioneer invention doctrine on the basis that it is *even more* difficult to draft claim language adequately protecting a new, groundbreaking invention.¹¹⁰

(2002) (arguing that pioneer inventors in the biomedical area are unable to obtain full claim scope, thereby “provid[ing] minor improvers undeserved protection”).

107. Meurer & Nard, *supra* note 3, at 1950 (“To the extent that a modern justification for the doctrine can be inferred, it apparently starts with the belief that . . . sometimes frictions in the system cause patent claims to be too narrow. The proper role of the [doctrine of equivalents] is to overcome these frictions and restore the proper breadth.”); see Sarnoff, *supra* note 89, at 1181–83.

108. See Meurer & Nard, *supra* note 3, at 1968–70; Sarnoff, *supra* note 89, at 1181–83.

109. Festo Corp. v. Shoketsu Kinzoku Kogyo Kabushiki Co., 535 U.S. 722, 731 (2002) (“If patents were always interpreted by their literal terms, their value would be greatly diminished. Unimportant and insubstantial substitutes for certain elements could defeat the patent, and its value to inventors could be destroyed by simple acts of copying.”); Meurer & Nard, *supra* note 3, at 1968; Joseph S. Cianfrani, Note, *An Economic Analysis of the Doctrine of Equivalents*, 1 VA. J.L. & TECH. 1, ¶ 30 (1997).

110. Moore v. United States, 211 U.S.P.Q. 800, 806 (Ct. Cl. 1981) (“The doctrine finds its roots in the judicial recognition that drafting the disclosure and claims for a pioneer patent is a difficult task because of the new scientific ground being broken by the unique invention. . . . [T]he doctrine of equivalents remedies the anomaly in the law that exists whenever a pioneer patent is not literally infringed by the very subject matter which was spawned by the disclosure of that pioneer patent.”), *aff’d*, 706 F.2d 319 (Fed. Cir. 1983); see Meurer & Nard, *supra* note 3, at 2003–04 (“[T]he only persuasive argument courts or commentators have offered for special treatment of pioneer inventions under the [doctrine of equivalents] is that pioneer inventors face greater frictions than other inventors.”); Thomas, *supra* note 3, at 52–53 (“Compared with drafters’ attempts at claims describing more modest technological advances, courts believe that drafters of pioneer invention claims are less able to capture the significance of the inventor’s contribution”); see also Azure, *supra* note 104, at 1181 (noting “the inherent difficulty of drafting claims for pioneering inventions”).

1. Prosecution Frictions

One friction is the difficulty inherent in describing an invention in words. According to this line of argument, it is simply impossible for an inventor to draft a patent claim covering the entirety of her invention because words do not map well to physical objects.¹¹¹ As one court put it, the “conversion of machine to words allows for unintended idea gaps which cannot be satisfactorily filled.”¹¹² According to pioneer doctrine proponents, if it is difficult for a typical inventor to describe her creation adequately, it must be exceptionally difficult for a pioneer inventor who, by definition, has invented something wholly new and unique.¹¹³ By virtue of the extraordinary novelty of pioneering inventions, they argue, pioneer inventors will frequently have to overcome an even larger gulf between language and technology.¹¹⁴

Two related frictions stem from the fact that patents are, in addition to technical disclosures, legal documents typically prepared by third parties. Over the decades, certain claim-drafting practices that have little to do with facilitating the accurate description of inventions have developed among the patent bar.¹¹⁵ These arcane rules, which have far more in common with standard legalese found in commercial contracts than with technical writing techniques, may be

111. See *Festo*, 535 U.S. at 731 (“Unfortunately, the nature of language makes it impossible to capture the essence of a thing in a patent application. The inventor who chooses to patent an invention . . . bears the risk that others will devote their efforts toward exploiting the limits of the patent’s language . . .”); see also Burk & Lemley, *supra* note 39, at 1745 (“[C]laim construction may be inherently indeterminate: it may simply be impossible to cleanly map words to things.”); David L. Schwartz, *Practice Makes Perfect? An Empirical Study of Claim Construction Reversal Rates in Patent Cases*, 107 MICH. L. REV. 223, 259 (2008) (“Claim construction may be inherently indeterminate.”); Cianfrani, *supra* note 109, ¶ 31 (arguing that claim language is “inherently incapable of perfectly capturing the essence of an invention”).

112. *Autogiro Co. of Am. v. United States*, 384 F.2d 391, 397 (Ct. Cl. 1967).

113. See *Meurer & Nard*, *supra* note 3, at 2004 n.267 (“[C]ourts and commentators suggest that the limitations of language are more troubling for pioneers . . .”).

114. *Moore*, 211 U.S.P.Q. at 806 (“[D]rafting the disclosure and claims for a pioneer patent is a difficult task because of the new scientific ground being broken by the unique invention.”); *Autogiro*, 384 F.2d at 397 (“Often the invention is novel and words do not exist to describe it. The dictionary does not always keep abreast of the inventor. It cannot. Things are not made for the sake of words, but words for things.”); Douglas Lichtman, *Rethinking Prosecution History Estoppel*, 71 U. CHI. L. REV. 151, 176 (2004) (“[I]n complicated or rapidly evolving technologies . . . it is more difficult for applicants to write appropriate claims in the first instance . . .”).

115. See Thomas, *supra* note 3, at 53–56 (listing many examples of “startlingly arcane” claim drafting conventions that “dat[e] back to the earliest days of United States patent claiming practice,” including the means-plus-function, product-by-process, *Markush*, and *Jepson* claim formats).

surprisingly counterintuitive and thus serve as a trap for unwary prosecutors or inventors.¹¹⁶ Also, apart from frictions associated with the technicalities of claim drafting, a more common and subtle source of friction is the communication gap that exists between technology-oriented inventors and legally trained patent prosecutors.¹¹⁷ The perception exists that many patents are unduly narrow because—in addition to the effect of ordinary agency costs associated with any principal-agent relationship¹¹⁸—patent prosecutors simply fail to comprehend, and thus to claim, the full extent of the invention.¹¹⁹

116. One example is the shockingly important distinction in patent law between two terms that are normally synonymous: “comprising” and “consisting of.” U.S. PATENT & TRADEMARK OFFICE, MANUAL OF PATENT EXAMINING PROCEDURE [hereinafter MPEP] § 2111.03 (8th ed., rev. July 2010), available at <http://www.uspto.gov/web/offices/pac/mpep/index.html> (“The transitional term ‘comprising’ . . . is inclusive or open-ended and does not exclude additional, unrecited elements or method steps. . . . The transitional phrase ‘consisting of’ excludes any element, step, or ingredient not specified in the claim.”).

117. Literature reporting the low quality of attorney-client communication and suggesting methods for improvement is legion. See, e.g., Thomas J. Watson, *Improving Lawyers’ Image Starts with Client Relations*, 80 WIS. LAW., July 2007, at 23, 23 (reporting that in a Gallup poll “80 percent of respondents said lawyers should do a better job of communicating with clients”).

118. Some commentators have cautioned that agency costs may be higher than expected in the inventor-prosecutor relationship. For example, John R. Thomas has suggested that it is quite hard for inventors to evaluate the performance of patent prosecutors. John R. Thomas, *Claim Re-Construction: The Doctrine of Equivalents in the Post-Markman Era*, 9 LEWIS & CLARK L. REV. 153, 168 (2005) (“It is . . . an extremely difficult task to assess the capabilities of a particular claim drafter beyond a rudimentary level. . . . [This is true] even for sophisticated enterprises.”); see also 3 RONALD E. MALLEN & JEFFREY M. SMITH, LEGAL MALPRACTICE § 23.23, at 591 (5th ed. 2000 & Supp. 2002) (“Because patent law practice is so technically sophisticated, even to the ordinary attorney, few clients recognize when a patent attorney erred.”). Also, because only a tiny percentage of patents will ever be asserted, prosecutors have little incentive to eradicate inconspicuous errors because any given oversight is unlikely to ever be discovered by an adversary. See Lemley & Shapiro, *supra* note 25, at 79 (“Only 1.5 percent of all patents are ever litigated, and only 0.1 percent are litigated to trial” (citations omitted)).

119. *In re Wilder*, 736 F.2d 1516, 1519 (Fed. Cir. 1984) (“An attorney’s failure to appreciate the full scope of the invention is one of the most common sources of defects in patents.”); see also Martin J. Adelman & Gary L. Francione, *The Doctrine of Equivalents in Patent Law: Questions That Pennwalt Did Not Answer*, 137 U. PA. L. REV. 673, 711 (1989) (“Most frequently, patent holders use the doctrine of equivalents to rectify what is effectively a ‘mistake’ in the process of drafting and prosecuting the application in the PTO.”); Meurer & Nard, *supra* note 3, at 1994 n.219 (“[T]here is significant anecdotal evidence suggesting that prosecutors viewed the [doctrine of equivalents] as a safety net for prosecutorial mistakes.”); Sarnoff, *supra* note 89, at 1208 (“The modern doctrine of equivalents thus operates principally as an insurance policy against potential but unrecognized mistakes in drafting”).

2. Timing Frictions

Two more frictions arise from patent law's preference for the early disclosure of inventions. First, because technology will inevitably advance between the time a patentee drafts his claims and asserts them in litigation, patentees face the risk of inadvertently drafting claims that fail to cover technological advances occurring after their patents issue.¹²⁰ Again, this friction is thought to be particularly pernicious for pioneer inventors drafting claims covering a nascent, quickly evolving technology.¹²¹ According to this argument, because a pioneer invention by definition creates a wholly new technical field, pioneer inventors are especially unlikely to foresee precisely where further development in the area will lead and, thus, are likely to draft claims that leave ample room for future competitors to design around their patent.¹²² This outcome is thought to be particularly unfair because it may result in a pioneer losing market share to a rival invention his own patent enabled.¹²³

120. *In re Hogan*, 559 F.2d 595, 606 (C.C.P.A. 1977) (“To now say that appellants should have disclosed in 1953 the amorphous form which on this record did not exist until 1962, would be to impose an impossible burden on inventors and thus on the patent system.”); Meurer & Nard, *supra* note 3, at 1970 (noting that another “source of friction arises from the difficulty foreseeing technical developments relevant to the patented technology”); Note, *Estopping the Madness at the PTO: Improving Patent Administration Through Prosecution History Estoppel*, 116 HARV. L. REV. 2164, 2176 (2003) (“The doctrine of equivalents is most valuable in emerging technologies . . . [where] technology is changing so quickly that [patentees] cannot predict how competitors might try to design around their patents.”).

121. Meurer & Nard, *supra* note 3, at 2004 n.267 (“[C]ourts and commentators suggest . . . that pioneers are more troubled by later developed technology.”); Thomas, *supra* note 3, at 52–53.

122. Meurer & Nard, *supra* note 3, at 2004 (“[W]e conjecture that many pioneer inventors face a tougher problem visualizing and enumerating the many possible methods of imitating a pioneer invention.”); Baker, *supra* note 67, at 451 (“When a pioneer invention opens up a new technical area, the possibilities for development in that area are difficult to anticipate. The patent drafter can easily overlook all the ways in which a seemingly essential feature of the invention can be redesigned”); Fillman, *supra* note 106, at 529 (“Future variations are difficult to predict and claim in written form, but since they come so rapidly, minor variations rob patents of their value.”); Steinhauer, *supra* note 70, at 524 (“Although future technological advances may be generally foreseen by a pioneer, the specific limitations are unknowable and thus the claim language cannot include them.”).

123. *In re Goffe*, 542 F.2d 564, 567 (C.C.P.A. 1976) (“For all practical purposes, the board would limit appellant to claims involving the specific materials disclosed in the examples, so that a competitor seeking to avoid infringing the claims would merely have to follow the disclosure in the subsequently-issued patent to find a substitute. However, to provide effective incentives, claims must adequately protect inventors.”); Merges & Nelson, *supra* note 28, at 848; Baker, *supra* note 67, at 452 (“Competitive products are often made possible only by the innovation of the pioneer inventor. If such products avoid

Second, in an effort to establish priority of invention and avoid statutory bars, an inventor may be pressured to file a patent application prematurely without claiming the many aspects of his invention that remain unfinished and untested.¹²⁴ Again, commentators argue, inventors of pioneer innovations are particularly susceptible to this friction because inventions in nascent fields are more amorphous and require even more experimentation and testing.¹²⁵

3. Examination Frictions

Examination by the PTO offers a final opportunity for the introduction of friction. Patent examiners must review proposed claims subject to the same limitations of language that make claim drafting so difficult for patentees and, even more so than patentees, examiners find it difficult to predict how technology will develop in the future.¹²⁶ This uncertainty, commentators reason, understandably leads to disagreement between examiners and applicants. This disagreement in turn leads to claim rejections, and these rejections to narrowing amendments.¹²⁷ Taking the argument one step further,

infringement, . . . [s]uch a result is particularly unjust"); Steinhauer, *supra* note 70, at 523.

124. Wegner, *supra* note 104, at 36 (“[A]ccelerated patent prosecution . . . puts pressure on patent attorneys to draft initial claims that will cover all foreseeable commercial embodiments of an invention that is often still in the evolutionary process. Where only the clear vision of hindsight permits the drafting of claims of adequate scope, some form of the doctrine of equivalents is necessary.”). See generally Christopher A. Cotropia, *The Folly of Early Filing in Patent Law*, 61 HASTINGS L.J. 65 (2009) (questioning whether patent law should encourage early filing of patent applications). Wegner argues that the U.S. patent system’s relative quickness “puts its patent applicants at a competitive disadvantage compared to applicants in Europe and Japan, where the patent systems . . . allow[] a much longer time for patent prosecution.” Wegner, *supra* note 104, at 36 & n.125 (noting that patent examination in Japan “may be deferred for up to seven years”). The new America Invents Act changes U.S. priority rules so that patent rights go to the first to file an application and therefore not necessarily to the first to invent. See Leahy-Smith America Invents Act, Pub. L. No. 112-29, § 3, 125 Stat. 284, 285–86 (2011); see also *supra* note 12 (discussing how the America Invents Act changes U.S. priority rules). In a first-to-file regime, inventors will have even greater incentives to seek a patent quickly. See Dennis D. Crouch, *Is Novelty Obsolete? Chronicling the Irrelevance of the Invention Date in U.S. Patent Law*, 16 MICH. TELECOMM. & TECH. L. REV. 53, 62 (2009).

125. See Baker, *supra* note 67, at 451 (“In contrast to a mere improvement, a pioneer invention usually has more features that are untested.”).

126. Lichtman, *supra* note 114, at 177–78 (“Patent prosecution takes place early in the development of a technology, long before relevant information is available about how the invention will mature and what its economic implications will be.”).

127. *Id.* at 178 (“[T]he doctrine of equivalents holds out the possibility that, in rare but appropriate circumstances, courts may in essence redraw claim boundaries using

commentators argue that the PTO is especially ill-equipped to properly examine pioneer claims and will frequently deny pioneer inventors the broad claim scope they deserve.¹²⁸

4. Competition Magnifies Frictions

Finally, commentators argue, all of these frictions are particularly detrimental to pioneers because pioneer inventions are far more likely than average to be challenged in court.¹²⁹ According to this theory, rivals hoping to break into the industry created by a pioneer invention are likely to challenge the pioneer's patent rights in court, and the more times a patent is litigated, the more likely it is that a competitor will eventually exploit a weakness caused by friction to avoid infringement.¹³⁰

B. Broad Pioneering Rights Increase Overall Innovation

In addition to friction-based reasoning, commentators have argued that granting broad patent scope to pioneer inventors increases the overall level of innovation. These arguments generally take one of two forms: first, that broad patent rights act as a strong ex ante incentive for the creation of extraordinary inventions and, second, that broad rights permit pioneer inventors to coordinate the efficient development of improvements to their inventions ex post.

1. Ex Ante Incentive for Revolutionary Invention

To some commentators, the patent system fails to provide sufficient incentive for the creation of revolutionary inventions. There is, they argue, at any given time a number of potentially revolutionary inventions lying just beyond the reach of the innovation-inducing invisible hand of the current patent system. Though these inventions

information that was not available at the time of patent prosecution . . . [L]ack of information . . . increases the likelihood that the examiner will disagree about the appropriate literal language and therefore require the applicant to make changes during patent prosecution.”); see Meurer & Nard, *supra* note 3, at 1953 n.27 (“Arguably, courts should be allowed to expand claim scope at trial because the passage of time and the adversarial nature of the proceeding gives them better information than the earlier ex parte proceeding at the PTO.”).

128. See Lichtman, *supra* note 114, at 176 (“[I]n complicated or rapidly evolving technologies—technologies about which it is more difficult for applicants to write appropriate claims in the first instance . . . there is more room for reasonable disagreement between applicant and examiner . . .”).

129. See Baker, *supra* note 67, at 452 (“When potential profits are high, competitors are more likely to challenge a patent’s limits and validity, either through litigation or by attempting design arounds.”).

130. See *id.*

would be extraordinarily beneficial to society if developed, they are not pursued with an efficient level of fervor because their development is fraught with unpredictable costs and a high risk of complete failure.¹³¹ Without additional incentive from the patent system, commentators fear, such inventions will be long-delayed or never developed at all.¹³²

2. Ex Post Opportunity for Coordination, Especially in the Pharmaceutical Industry

To other commentators, broad patent rights are beneficial because they encourage patent owners to explore, improve, and commercialize undeveloped areas of the inventive space fenced in by their claims. This line of argument derives from Edmund Kitch's decades-old "prospect theory" of patent protection.¹³³

Kitch's theory, which he hoped would integrate the study of intellectual property and real property rights, analogizes the tragedy

131. Oddi, *supra* note 104, at 1115 ("Although the potential benefits to the inventor of revolutionary inventions are high, there are correspondingly high and unpredictable costs associated with their development In this instance, the patent system should provide a special incentive for committing significant resources to high-risk ventures whose outcome may range from a truly revolutionary invention to a failed experiment."); Baker, *supra* note 67, at 451 ("[W]hen the organizations behind innovation structure their research and development programs, they must consider the marginal benefits of their investments. With greater value afforded to pioneer inventions, these organizations will be more likely to direct research and development toward the most challenging technical problems, where the risk of failure is great.").

132. See Baker, *supra* note 67, at 450-53. To other commentators, the pioneer doctrine primarily operates as a rough form of societal restitution to inventors, in which the public returns to the inventor ex post some portion of the inventive (or public) domain as a reward for bestowing an extraordinary benefit upon society. See Thomas, *supra* note 3, at 58 ("[A] liberal interpretation [of pioneer claims] flows from the belief that in the exchange of technological disclosure for exclusive rights, the public received an extraordinary bargain, for which the pioneer inventor should receive additional compensation." (footnote omitted)). Consider, for example, the court's generous description of Whitney's cotton gin in *Whitney v. Carter*:

Is there a man who hears us who has not experienced its utility? The whole interior of the Southern states was languishing . . . when the invention of this machine at once opened views to them which set the whole country in active motion. From childhood to age, it has presented us a lucrative employment. Individuals who were depressed with poverty, and sunk in idleness, have suddenly risen to wealth and respectability. Our debts have been paid off, our capitals increased, and our lands have trebled in value. We cannot express the weight of obligation which the country owes to this invention; the extent of it cannot now be seen.

29 F. Cas. 1070, 1072 (C.C.D. Ga. 1810) (No. 17,583).

133. See Kitch, *supra* note 105, at 266.

of the commons to patent law to argue that broad patent rights encourage patentees to improve and commercialize their inventions much in the same way that exclusive property ownership encourages landowners to put their land to the most efficient use.¹³⁴ The “tragedy of the commons” is traditional economic shorthand for the fact that those using a common piece of property will tend to overuse and exhaust the property’s resources because each individual user enjoys the benefits of her personal use, but shares the costs with all other users.¹³⁵ Thus, common pastures will be overgrazed, common waters overfished, common woodlands deforested, and the like.¹³⁶ Destruction of the commons is solved by assigning property rights to individual users, who as property owners bear the full cost of their actions and, thus, have appropriate incentives to use their land responsibly.¹³⁷ Combined with Coasean notions of cost-free bargaining, property rights further permit the newly minted property owners to enter into transactions with one another that will eventually put their land to the best use possible.¹³⁸ Landowners will gladly sell neighboring ranchers grazing rights to their unused grasslands, will efficiently harvest their own fisheries and forests or sell rights to others who can, and so on until the most efficient allocation is achieved.

To Kitch, inventive space is just as susceptible to waste as a real property commons. Like ranchers sharing a common field, inventors racing to secure patent rights related to a particular technological area will tend to “overgraze.” That is, as inventors race to patent various aspects of a new innovation, they will engage in wasteful and duplicative inventive activity in hopes of securing as much of the available inventive space as possible before it is completely patented.¹³⁹

Prospect theory posits that the solution to inefficient inventive rivalry is the same as the solution to overuse of common resources:

134. *Id.* at 276.

135. Garrett Hardin, *The Tragedy of the Commons*, 162 *SCIENCE* 1243, 1244 (1968).

136. *See id.* at 1244–45.

137. *Id.* at 1245.

138. *See* Guido Calabresi & A. Douglas Melamed, *Property Rules, Liability Rules, and Inalienability: One View of the Cathedral*, 85 *HARV. L. REV.* 1089, 1095 (1972) (“In such a frictionless society, transactions would occur until no one could be made better off as a result of further transactions without making someone else worse off.”).

139. *See, e.g.*, Pankaj Tandon, *Rivalry and the Excessive Allocation of Resources to Research*, 14 *BELL J. ECON.* 152, 152 (1983) (developing an economic model that suggests “there may be a tendency for firms to perform excessive R&D, or . . . [to] ‘rush to invent’ which dissipates much of the social benefit from research”).

exclusive rights. Kitch observed that, much in the same fashion that the mineral claim system allows a prospector to secure the exclusive right to develop a newly discovered mineral deposit before engaging in full-scale excavation, the patent system allows an inventor to secure broad patent rights covering a technological discovery well before that discovery has been fully explored, advanced, and commercialized.¹⁴⁰ According to Kitch, this is advantageous because it consolidates in the hands of one inventor control of a broad swath of inventive space and thereby eliminates competitors' incentives to race to claim a portion of that space.¹⁴¹ Just as importantly, Kitch argues, it permits the patent holder to coordinate exploration and commercialization of the entire technological area by licensing the right to commercialize portions of the prospect to the firms best positioned to do so.¹⁴²

Prospect theory thus suggests that innovation is optimally incentivized when a single entity is vested early on with broad patent rights that allow it to control an entire technological field. If broad rights do indeed encourage the development and commercialization of improved embodiments and related inventions, one might expect broad rights to be particularly beneficial for a pioneer inventor whose invention by definition created an entirely new field of technological endeavor.

Commentators point to the pharmaceutical industry as the modern industry most suited to Kitch's vision of the patent system.¹⁴³ R&D costs in the pharmaceutical industry are exceptionally high and, even after a new drug is developed, it must be approved by the FDA before it can be sold to the public.¹⁴⁴ Further, absent strong patent

140. Kitch, *supra* note 105, at 267–75.

141. *Id.* at 276.

142. *Id.* at 279.

143. See, e.g., Burk & Lemley, *Policy Levers*, *supra* note 9, at 1616 (“The prospect vision of patents maps most closely onto invention in the pharmaceutical industry.”).

144. Industry estimates of the cost of new drug creation range as high as \$1 billion. See Joseph A. DiMasi & Henry G. Grabowski, *The Cost of Biopharmaceutical R&D: Is Biotech Different?*, 28 *MANAGERIAL & DECISION ECON.* 469, 470 (2007); see also BOLDRIN & LEVINE, *supra* note 11, at 215 (“[R]ecent estimates . . . place the total cost of bringing a new drug to market at around \$800 million, in year 2000 dollars. Even if a number of researchers have questioned [the] methodology [behind these estimates], this figure suggests a spectacular increase in the cost of innovating. This increase is due, mostly, to the capitalization of the longer and more expensive clinical trials the . . . [FDA] requires.” (footnote omitted)). See generally MERRILL GOOZNER, *THE \$800 MILLION PILL: THE TRUTH BEHIND THE COST OF NEW DRUGS* (2004) (examining the factors that drive the cost of new drugs and concluding that a significant amount of innovation is funded by the public, as opposed to the private sector).

protection, imitation in the pharmaceutical industry is relatively easy. If an inventor's rights are limited to the precise composition he intends to sell, competitors can readily develop a generic alternative using a close chemical analog and, in some circumstances, can avoid the FDA approval process altogether.¹⁴⁵ Thus, in the face of fierce inventive rivalry, pharmaceutical firms may choose not to make the large investments necessary to develop a new drug.¹⁴⁶

3. Clearing Patent Thickets, Especially in the Biotechnology Industry

Finally, in a more modern corollary to Kitch's prospect theory, several scholars have argued that extending broad patent rights to pioneers may increase overall innovation in industries where "patent thickets" or "anticommons" make the development of new technologies more costly.¹⁴⁷ A patent thicket arises when multiple patents with overlapping scope cover the same product.¹⁴⁸ Similarly, an anticommons exists where inputs to, or steps in the manufacture of, a final product were individually patented by multiple inventors.¹⁴⁹ In both situations, the fragmented nature of patent rights impedes innovation because a company hoping to sell a product must

145. By filing an Abbreviated New Drug Application, a generic drug manufacturer can seek FDA approval before name-brand manufacturers' patents expire. See Federal Food, Drug, and Cosmetic Act § 505(j), 21 U.S.C. § 355(j) (2006); see also *Eli Lilly & Co. v. Medtronic, Inc.*, 496 U.S. 661, 676–77 (1990) (describing the generic drug review process).

146. Brief of Amici Curiae the Regents of the University of California et al. on En Banc Rehearing in Support of Affirmance of Judgment at 9, *Ariad Pharm., Inc. v. Eli Lilly & Co.*, 598 F.3d 1336 (Fed. Cir. 2010) (No. 2008-1248), 2009 WL 3657817 ("Patent exclusivity granted for pioneering biological inventions fuels the creation and recruitment of commercial entities willing to undertake the huge investments necessary to refine and develop foundational university research into medical and biopharmaceutical products widely accessible to the general public. Denial of patent protection for university inventions removes the incentive for private investment in the commercialization of biotechnological inventions, keeping important and possibly life-saving advancements out of the public's reach . . .").

147. Kitch's work, in fact, suggests the existence of these problems. See Kitch, *supra* note 105, at 285 ("[A] claim system may generate separate ownership rights in areas that upon further development turn out to be subject to the most efficient exploitation under unified control.").

148. See Carl Shapiro, *Navigating the Patent Thicket: Cross Licenses, Patent Pools, and Standard-Setting*, in 1 INNOVATION POLICY AND THE ECONOMY 119, 119–20 (Adam B. Jaffe et al. eds., 2000).

149. See Michael A. Heller, *The Tragedy of the Anticommons: Property in the Transition from Marx to Markets*, 111 HARV. L. REV. 621, 622 (1998) ("In an anticommons . . . multiple owners are each endowed with the right to exclude others from a scarce resource, and no one has an effective privilege of use. When too many owners hold such rights of exclusion, the resource is prone to underuse—a tragedy of the anticommons."); Michael A. Heller & Rebecca S. Eisenberg, *Can Patents Deter Innovation? The Anticommons in Biomedical Research*, 280 SCIENCE 698, 699–700 (1998).

negotiate licenses with multiple patent owners or risk suit for patent infringement.

Commentators point to the biotechnology industry as the modern industry most hampered by splintered ownership of patent rights. In many areas of biotechnology, patent rights hinder innovators' access to both vertical and horizontal complements. Among many others, inventors have patented laboratory animals, reagents, stem cell lines, DNA sequencing algorithms, and tens of thousands of DNA sequences covering genes and gene fragments.¹⁵⁰ As a result, any current innovator hoping to develop a new biomedical treatment or diagnostic test must first obtain multiple licenses from multiple patent owners or risk suit for infringement. To the extent that it is even possible (as a practical matter) to license all relevant patent rights from their various owners, paying numerous royalties to enter the market significantly reduces incentives to invest in the development of new technology.¹⁵¹

III. AGAINST THE PIONEER DOCTRINE

Though plausible on their face, below the surface these oft-repeated justifications for the pioneer doctrine contradict empirical evidence, historical experience, and economic theory. This part counters each argument presented above. Indeed, these arguments fare no better than scholarly consensus on the doctrine's irrelevance. As noted below, pioneers receive extraordinarily broad claim scope without help from the pioneer doctrine, and historical evidence strongly suggests that innovation suffers in markets dominated by patentees with near monopoly power.

A. *Patent-Drafting Frictions Are Illusory*

Contrary to the assertions of pioneer doctrine advocates, concerns about claim scope frictions are greatly overstated. Indeed, it is almost certainly true that these frictions affect pioneers *even less* than they affect ordinary applicants.

150. See Arti K. Rai & Rebecca S. Eisenberg, *Bayh-Dole Reform and the Progress of Biomedicine*, 66 LAW & CONTEMP. PROBS. 289, 297 (2003). The patentability of DNA sequences was recently affirmed by the Federal Circuit. See *infra* note 352.

151. See Shapiro, *supra* note 148, at 124 (“[T]he prospect of paying [multiple] royalties necessarily reduces the return to new product design and development, and thus can easily be a drag on innovation and commercialization of new technologies.”).

1. Pioneer Claims Are Simple to Draft

First, pioneer inventors should have the easiest time of all drafting broad patent claims. The reason is simple: by definition, pioneer inventions open up new fields in which little or no prior art exists.¹⁵² Much of the difficulty associated with claim drafting stems from the need to draft long, complex claims to distinguish the proposed invention from the prior art.¹⁵³ Free from the constraints of closely related prior art, pioneer inventors can draft claims using broad language.¹⁵⁴

There is simply no evidence that pioneer inventors draft unduly narrow claims.¹⁵⁵ To the contrary, many pioneers have drafted famously broad claims. Morse, for example, claimed “electromagnetism, however developed, for making or printing intelligible characters, letters, or signs, at any distances”—a claim so broad it covers every communication device on the market 170 years after it was issued.¹⁵⁶ Bell likewise claimed all of telephony—all devices “for transmitting vocal or other sounds . . . by causing electrical undulations, similar in form to the vibrations of the air accompanying the said vocal or other sounds.”¹⁵⁷

152. *Abbott Labs. v. Dey, L.P.*, 287 F.3d 1097, 1105 (Fed. Cir. 2002) (“A pioneer patent by definition will have little applicable prior art to limit it, whereas an improvement patent’s scope is confined by the existing knowledge on which the improvement is based.”); *Burk & Lemley, Policy Levers*, *supra* note 9, at 1656 (“There is little prior art in a newly opened field that would prevent the inventor from claiming broadly.”).

153. *See Thomas, supra* note 3, at 56 (“[Claim drafting] may be at its most difficult when an invention presents only a narrow advance in a crowded technological art, rather than a revolutionary advance.”).

154. *Augustine Med., Inc. v. Gaymar Indus., Inc.*, 181 F.3d 1291, 1301–02 (Fed. Cir. 1999) (“Without extensive prior art to confine and cabin their claims, pioneers acquire broader claims than non-pioneers who must craft narrow claims to evade the strictures of a crowded art field”); *Rai & Eisenberg, supra* note 150, at 296 (“Unconstrained by prior art, [patents on early stage discoveries] may be quite broad, permitting their owners to control subsequent research across a significant range of problems.”); *Thomas, supra* note 3, at 56 (“Because the field of endeavor in which the pioneer invention sits is sparse, inventors can draft short claims using sweeping language with ample technological scope.”).

155. What little empirical evidence there is suggests that pioneers do receive broad claims. John R. Thomas reviewed the prosecution history of pioneer patents and found that “the paucity of prior art was, if anything, the forerunner of a smooth prosecution despite the sweeping claims generally found in these patents.” *Thomas, supra* note 3, at 57. Thomas also surveyed a small number of patent prosecutors who reported that it is difficult to draft claims covering even simple devices in crowded arts. *Id.*

156. *O’Reilly v. Morse*, 56 U.S. (15 How.) 62, 86 (1853). The Supreme Court invalidated Morse’s claim for lack of enablement. *Id.* at 119–20.

157. *The Telephone Cases*, 126 U.S. 1, 531 (1888). The Supreme Court upheld Bell’s claim, despite recognizing that “electricity cannot be used at all for the transmission of

In addition, rather than acting to constrain claim scope, many technical claim-drafting rules actually facilitate the transformation of an invention into a broad claim. With means-plus-function claim language, an inventor can draft a claim covering all known “means for” performing some function, without limiting herself to a finite list of specific examples.¹⁵⁸ For example, an inventor can claim a “means for fastening” rather than reciting “nails, screws, rivets, tape, glue,” and a laundry list of every other possible means for attaching one thing to another.¹⁵⁹ The *Markush* claiming format similarly allows an inventor to claim an invention with an element selected from a known class of substitutes.¹⁶⁰

Other, far simpler conventions also help mitigate language-related frictions. Notably, U.S. patent law permits applicants to file multiple independent and dependent claims. Thus inventors never have to choose between two roughly equal descriptive words or decide whether to tempt fate with a riskier claim formulation rather than settle for a safer alternative. Subject to the cost of PTO and attorneys’ fees, inventors can always avoid these risks by filing multiple claims.¹⁶¹ Courts also routinely uphold patent claims that contain terms of degree like “approximate,” “substantially,” and “readily.”¹⁶² Finally, if all else fails, patentees are free to simply

speech except in the way Bell has discovered, and that, therefore, practically, his patent gives him its exclusive use for that purpose . . .” *Id.* at 535.

158. 35 U.S.C. § 112 (2006) (“An element in a claim for a combination may be expressed as a means or step for performing a specified function without the recital of structure, material, or acts in support thereof, and such claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof.”); *see also supra* note 15 (providing a brief overview of changes made to § 112 by the America Invents Act). Means-plus-function claiming does, however, limit the inventor to contemporary technology. *See, e.g., Al-Site Corp. v. VSI Int’l, Inc.*, 174 F.3d 1308, 1320 (Fed. Cir. 1999) (noting that means-plus-function claims are strictly limited to structural equivalents “available at the time of the issuance of the claim”).

159. ROBERT PATRICK MERGES & JOHN FITZGERALD DUFFY, *PATENT LAW AND POLICY: CASES AND MATERIALS* 31–32 (3d ed. 2002); *see also Al-Site Corp.*, 174 F.3d at 1316–17 (interpreting the phrase “fastening means”).

160. *See MPEP, supra* note 116, § 803.02 (citing *Ex parte Markush*, 1925 C.D. 126 (Comm’r Pat. 1925)). *Markush* claims are most often used to claim all functionally-equivalent members of a recognized chemical class. *Id.*

161. PTO fees increase with the number of claims submitted for examination. *See* 37 C.F.R. § 1.16(h)–(j) (2010).

162. *See Hearing Components, Inc. v. Shure, Inc.*, 600 F.3d 1357, 1366 (Fed. Cir. 2010) (holding that “the claim limitation ‘readily installed and replaced by a user’ is not indefinite”); *Verve, L.L.C. v. Crane Cams, Inc.*, 311 F.3d 1116, 1120 (Fed. Cir. 2002) (“It is well established that when the term ‘substantially’ serves reasonably to describe the subject matter . . . it is not indefinite.”); *Andrew Corp. v. Gabriel Elecs., Inc.*, 847 F.2d 819, 821–22 (Fed. Cir. 1988) (noting that the claim terms “closely approximate” and “substantially equal” are “ubiquitous in patent claims” and “have been accepted in patent

construct their own terminology: it is a venerable canon of claim construction that a patentee may “act[] as his or her own lexicographer.”¹⁶³

Concerns about mistakes during prosecution are also likely overblown. Several scholars, for example, observe that most alleged prosecution “errors” were, in reality, calculated claim-drafting decisions that only look foolish in hindsight.¹⁶⁴ In any event, when patent claims are inadvertently issued in a narrowed format, the Patent Act itself provides a corrective mechanism. Section 251 of the Act permits the PTO to “reissue” patents that were “defective” when originally issued.¹⁶⁵ Under this provision, a patentee can request, within two years of her patent’s issuance, that the PTO reissue the patent “in accordance with a new and amended application” if the patent was defective “by reason of the patentee claiming . . . less than he had a right to claim in the patent.”¹⁶⁶ The reissue mechanism, which has been available to patentees since at least the early 1830s,¹⁶⁷ was actually designed to facilitate the correction of claim-drafting mistakes.¹⁶⁸

examination and upheld by the courts”); *see also* *Pall Corp. v. Micron Separations, Inc.*, 66 F.3d 1211, 1217–18 (Fed. Cir. 1995) (“about”); *Rosemount, Inc. v. Beckman Instruments, Inc.*, 727 F.2d 1540, 1546–47 (Fed. Cir. 1984) (“close proximity”).

163. *See* *Phillips v. AWH Corp.*, 415 F.3d 1303, 1319 (Fed. Cir. 2005); *see also id.* at 1316 (“Consistent with that general principle, our cases recognize that the specification may reveal a special definition given to a claim term by the patentee that differs from the meaning it would otherwise possess. In such cases, the inventor’s lexicography governs.”).

164. *Meurer & Nard*, *supra* note 3, at 1974 (noting that narrow claim language in many cases is the result of the fact that “prosecutors and inventors strategically choose narrow claims to limit disclosure to the examiner and avoid patentability problems, or because the inventor decides to seek a mix of patent and trade secret protection”); *Sarnoff*, *supra* note 89, at 1207 (“[I]n most (if not all) cases, errors in failing to claim equivalents actually reflect strategic decisions in prosecuting patents rather than failures of judgment.”). At the very least, poorly drafted patent claims reflect an inventor’s failure to devote additional time and resources to prosecution. *See* F. Scott Kief, *The Case for Registering Patents and the Law and Economics of Present Patent-Obtaining Rules*, 45 B.C. L. REV. 55, 110 (2003); *Meurer & Nard*, *supra* note 3, at 1971 (“Inventors can reduce the likelihood of mistakes by spending more time and money on prosecution, choosing a prosecutor with a good reputation, and effectively monitoring the prosecution.”).

165. 35 U.S.C. § 251 (2006).

166. *Id.*; *see also* *Johnson & Johnston Assoc., Inc. v. R.E. Serv. Co.*, 285 F.3d 1046, 1055 (Fed. Cir. 2002) (“A patentee who inadvertently fails to claim disclosed subject matter, however, is not left without remedy. Within two years from the grant of the original patent, a patentee may file a reissue application and attempt to enlarge the scope of the original claims to include the disclosed but previously unclaimed subject matter.”).

167. *See* *Grant v. Raymond*, 31 U.S. (6 Pet.) 218, 240–43 (1832). Reissue was first codified in 1836. *See* Patent Act of 1836, ch. 357, § 13, 5 Stat. 117, 122 (repealed 1952).

168. *See* *Topliff v. Topliff*, 145 U.S. 156, 171 (1892) (arguing that “the obvious intent” behind the reissue mechanism is to compensate for the fact “that valuable inventions are

Further, courts occasionally apply the doctrine of equivalents to stretch even the most precise claim language. In *Winans v. Denmead*,¹⁶⁹ for example, the Supreme Court held that a claim covering a conical or cylindrical coal-carrying railroad car—a car shaped “in the form of a frustum of a cone”—could, under the doctrine of equivalents, cover an accused car that was octagonal in shape.¹⁷⁰ Similarly, in *Warner-Jenkinson Co. v. Hilton Davis Chemical Co.*,¹⁷¹ the Court held that a rather exacting claim for a dye purification process requiring a pH level in the range “approximately 6.0 to 9.0” could, under the doctrine of equivalents, be stretched to cover an accused process using a pH of 5.0.¹⁷²

Finally, when faced with a clear mistake that is not otherwise remediable, patentees may seek recourse through the tort system. Malpractice lawsuits against patent agents and attorneys are common and act as a significant deterrent to prosecution errors.¹⁷³

2. Pioneer Claims Expand to Capture Later-Arising Technology

It is also untrue that technology arising after a patent is issued places the inventor’s patent rights in jeopardy. Patentees may assert their claims against these technologies literally or through the doctrine of equivalents.

a. Literally

First, a patent’s literal claim scope will frequently cover later-arising technology. One reason for the surprising elasticity of literal claim scope is the fact that word meanings tend to change over time to accommodate current needs. In particular, as a technical field matures, the scope of terminology in that field tends to expand with

often placed in the hands of inexperienced persons . . . [who] frequently fail to describe with requisite certainty the exact invention of the patentee”); see also *Graver Tank & Mfg. Co. v. Linde Air Prods. Co.*, 339 U.S. 605, 614–17 (1950) (Black, J., dissenting) (arguing that broad application of the doctrine of equivalents improperly supersedes the reissue process). Patentees very rarely take advantage of the opportunity to reissue patents. In 2010, the PTO issued more than 244,000 patents, but reissued only 947. *U.S. Patent Statistics Chart Calendar Years 1963–2010*, *supra* note 90.

169. 56 U.S. (15 How.) 330 (1853).

170. *Id.* at 339–40.

171. 520 U.S. 17 (1997).

172. See *id.* at 23, 32–33, 40–41.

173. See A. Samuel Oddi, *Patent Attorney Malpractice: An Oxymoron No More*, 2004 U. ILL. J.L. TECH. & POL’Y 1, 6 (2004) (finding that “courts have decided at least three times the number of malpractice cases against patent attorneys in the past fourteen years as in the first two hundred years of our federal patent system”).

time to encompass successive technological advances.¹⁷⁴ Because the meaning of claim terms will inevitably be determined by a judge many years after the patent issued,¹⁷⁵ patentees benefit from this subtle evolution.¹⁷⁶ In *SuperGuide Corp. v. DirecTV Enterprises*,¹⁷⁷ for example, the Federal Circuit held that the claim term “regularly received television signals” covered modern digital television even though the claim language was drafted in 1985.¹⁷⁸ Likewise, in *Laser Alignment, Inc. v. Woodruff & Sons*,¹⁷⁹ the Seventh Circuit held that the 1957 claim term “collimated beam of light” literally covered laser technology.¹⁸⁰ Patentees’ rights also continue in full force even if unanticipated advances in technology make it possible to use the patented invention in a new, unforeseeable way. For example, in *B.G. Corp. v. Walter Kidde & Co.*,¹⁸¹ the Second Circuit held that a spark plug patent, issued from an application filed in 1927, covered use of patented design in an airplane even though the inventor “did not foresee the particular adaptability of his plug to the airplane.”¹⁸²

174. Burk & Lemley, *supra* note 39, at 1757 (“Words change in meaning, sometimes slowly as language evolves, but sometimes with surprising rapidity. . . . Change in the meaning of language is particularly likely in the case of innovation, since the terms in question are often new and the concepts they represent are not yet fully understood.” (footnote omitted)); Mark A. Lemley, *The Changing Meaning of Patent Claim Terms*, 104 MICH. L. REV. 101, 102 (2005).

175. Generally, a year or two may pass between invention and the time a patent application is filed, *see* 35 U.S.C. § 102(b) (2006) (requiring that an application be filed within one year of a public use or sale of the invention); *see also supra* note 12 (describing the changes made to § 102 by the America Invents Act), 2.77 years on average will pass between filing and the patent’s issuance, Allison & Lemley, *supra* note 22, at 98, and many more years will pass between issue and claim construction, *see* John R. Allison & Mark A. Lemley, *Empirical Evidence on the Validity of Litigated Patents*, 26 AIPLA Q.J. 185, 237 (1998) (finding that on average 12.3 years pass between the time a patent application is filed and the resolution of a suit asserting the resulting patent).

176. Though the Federal Circuit has stated that claim terms are to be construed “at the time of the invention, i.e., as of the effective filing date of the patent application,” *see* Phillips v. AWH Corp., 415 F.3d 1303, 1313 (Fed. Cir. 2005) (en banc), claim construction is more nuanced in practice and courts have often interpreted claims to cover accused devices developed after those claims were filed, *see* Lemley, *supra* note 174, at 108–10. One notable exception is means-plus-function claims, which are strictly limited to structural equivalents “available at the time of the issuance of the claim.” *Al-Site Corp. v. VSI Int’l, Inc.*, 174 F.3d 1308, 1320 (Fed. Cir. 1999).

177. 358 F.3d 870 (Fed. Cir. 2004).

178. *Id.* at 876–81; *see also* Chiron Corp. v. Genentech, Inc., 363 F.3d 1247, 1257–58 (Fed. Cir. 2004) (noting that the meaning of the claim term “monoclonal antibody” changed greatly between 1984 and 1995, but declining to consider the term’s construction because the patent at issue was invalid).

179. 491 F.2d 866 (7th Cir. 1974).

180. *Id.* at 872.

181. 79 F.2d 20 (2d Cir. 1935).

182. *Id.* at 22.

Finally, the PTO has awarded broad claim scope to the initial inventors of synthetic versions of naturally occurring chemical and biological substances. In several cases, these inventors have been awarded claims covering not just the process for manufacturing the synthetic chemical, but also claims covering the substance itself. In *Parke-Davis & Co. v. H.K. Mulford & Co.*,¹⁸³ for example, Judge Learned Hand upheld a patent covering purified human adrenaline, not just the process for purifying the natural substance.¹⁸⁴ With claims covering the substance, these patentees can exclude all later-arising methods for making that substance, even ones that are fundamentally different and superior. In *Scripps Clinic & Research Foundation v. Genentech, Inc.*,¹⁸⁵ for example, the human blood clotting protein Factor VIII:C that Genentech produced using recombinant DNA technology was held to infringe Scripps's patent covering purified Factor VIII:C created using Scripps' older, less sophisticated process of deriving the protein from human blood plasma.¹⁸⁶

b. Under the Doctrine of Equivalents

Even if later-arising technology escapes claim construction it may still be covered by the doctrine of equivalents. Indeed, this is one of the principal reasons for the doctrine's existence.¹⁸⁷ The Supreme Court has expressly held that "the question under the doctrine of equivalents is whether an accused element is equivalent to a claimed

183. 189 F. 95 (C.C.S.D.N.Y. 1911), *aff'd in part, rev'd in part*, 196 F. 496 (2d Cir. 1912).

184. *Id.* at 102-03; *see also* *Merck & Co. v. Olin Mathieson Chem. Corp.*, 253 F.2d 156, 161-64 (4th Cir. 1958) (upholding patent covering purified vitamin B₁₂); *In re Bergstrom*, 427 F.2d 1394, 1401-02 (C.C.P.A. 1970) (reversing examiner's rejection of patent covering purified prostaglandin compounds). This line of precedent laid the foundation for later patents covering isolated DNA sequences. *See* Rebecca S. Eisenberg, *Patenting the Human Genome*, 39 EMORY L.J. 721, 727-29 (1990).

185. 666 F. Supp. 1379 (N.D. Cal. 1987), *aff'd in part, rev'd in part*, 927 F.2d 1565 (Fed. Cir. 1991).

186. *Id.* at 1390 ("Scripps is entitled to claim [in a product claim] purified Factor VIII:C having the characteristics of human Factor VIII:C, whether derived through its disclosed process or any other process achieving the same result."); *see also* *Hormone Research Found. v. Genentech, Inc.*, 904 F.2d 1558, 1562-64 (Fed. Cir. 1990) (determining that Genentech's recombinant DNA-produced synthetic HGH did not literally infringe Hormone Research Foundation's ("HRF") patent covering a synthetic HGH that HRF produced via an older "solid phase peptide synthesis process," but only because Genentech's synthetic hormone was chemically distinct from HRF's); *Amgen, Inc. v. Chugai Pharm. Co.*, 706 F. Supp. 94, 101 (D. Mass. 1989) (holding that recombinant DNA-produced EPO infringed a patent claiming purified EPO originally derived from urine). Both Amgen's and Scripps' claims were later invalidated on unrelated grounds. *See* *Amgen, Inc. v. Chugai Pharm. Co.*, 927 F.2d 1200, 1215-18 (Fed. Cir. 1991); *Scripps Clinic & Research Found. v. Genentech, Inc.*, 707 F. Supp. 1547, 1561 (N.D. Cal. 1989).

187. *See In re Hogan*, 559 F.2d 595, 606 (C.C.P.A. 1977).

element, the proper time for evaluating equivalency—and thus knowledge of interchangeability between elements—is at the time of infringement, not at the time the patent was issued.”¹⁸⁸

There is simply no evidence that pioneer inventors have been unfairly preempted by the arrival of new technology allowing competitors to easily design around their patent rights. To the contrary, in a number of cases even ordinary inventors have been generously rewarded under the doctrine of equivalents with broad claim scope covering later-developed technology. For example, the doctrine of equivalents has been used to protect patentees from unforeseen advancements in computer technology. In *Hughes Aircraft v. United States*,¹⁸⁹ the Federal Circuit held that a patent covering a means for controlling the attitude of a satellite by sending control signals from an earthbound station was infringed under the doctrine of equivalents by a later-developed system that controlled satellite attitude via a microprocessor located onboard the satellite.¹⁹⁰ Despite the clear distinction between the two systems, the Federal Circuit found them to be “identical . . . except for the employment of sophisticated, post-[invention] equipment (computers)” and held that such “an embellishment made possible by post-[invention] technology, does not allow the accused spacecraft to escape the ‘web of infringement.’ ”¹⁹¹

Finally, because equivalency is determined as a legal matter “at the time of infringement,”¹⁹² and as a practical matter during the course of litigation occurring well after infringement began, patentees benefit greatly from hindsight bias.¹⁹³ A judge, juror, or expert witness considering whether an improvement falls within or outside of the scope of a patent claim will necessarily rely on his opinion of the improvement today. Even if asked to do so, he will find it difficult or impossible to conceptualize what he would have thought of the improvement when it was discovered years ago. As a result, patentees benefit from the well-documented fact “that hindsight often leads observers to label obvious in retrospect an invention that was

188. *Warner-Jenkinson Co. v. Hilton Davis Chem. Co.*, 520 U.S. 17, 37 (1997).

189. 717 F.2d 1351 (Fed. Cir. 1983).

190. *Id.* at 1364–65; *see also* *Laser Alignment, Inc. v. Woodruff & Sons, Inc.*, 491 F.2d 866, 872–73 (finding the patent at issue infringed under the doctrine of equivalents).

191. *Hughes Aircraft*, 717 F.2d at 1365.

192. *Warner-Jenkinson*, 520 U.S. at 37.

193. *See* Julie E. Cohen & Mark A. Lemley, *Patent Scope and Innovation in the Software Industry*, 89 CALIF. L. REV. 1, 46 (2001).

significant at the time it was made.”¹⁹⁴ Thus, the backward-looking nature of the equivalency inquiry ensures that patentees’ claim scope will frequently expand to cover later-arising improvements.

3. Pioneers Can Freely Overclaim

It is also untrue that patentees must surrender claim scope in order to satisfy the patent system’s preference for early disclosure.

a. *Enablement, Reduction to Practice, and Utility*

Patentees benefit from a number of patent rules that permit them to claim more inventive ground than they explored and disclosed. For one, the PTO will only reject a proposed claim for lack of enablement if the patent examiner can point to specific documentary evidence suggesting that it is impossible to make a claimed embodiment without additional information.¹⁹⁵ As a result, the PTO frequently issues claims that “cover ground that examiners *believe*, but cannot prove, is well beyond the area actually explored and disclosed by the inventor.”¹⁹⁶ Enablement doctrine also permits a patentee to claim a generic class of materials thought to be substitutable at the time the patent was filed, even if a large portion of the class is later discovered to be inoperable.¹⁹⁷ Similarly, an inventor can quickly claim a compound made from a particular process before the inventor is capable of identifying the compound.¹⁹⁸

In fact, patent law permits an inventor to obtain a patent before building a prototype or even knowing for sure why—or even *whether*—the invention works as disclosed. Though an invention must be reduced to practice prior to patenting, the doctrine of constructive reduction to practice permits a purported inventor to file a patent

194. *Id.* Hindsight bias has been studied extensively in the literature of other disciplines. See, e.g., Jay J.J. Christensen-Szalanski & Cynthia Fobian Willham, *The Hindsight Bias: A Meta-Analysis*, 48 ORGANIZATIONAL BEHAV. & HUM. DECISION PROCESSES 147 *passim* (1991).

195. Merges & Nelson, *supra* note 28, at 848–49 (citing *In re Armbruster*, 512 F.2d 676, 680 (C.C.P.A. 1975); *In re Geerdes*, 491 F.2d 1260, 1265 (C.C.P.A. 1974)).

196. *Id.*

197. See *Atlas Powder Co. v. E.I. du Pont De Nemours & Co.*, 750 F.2d 1569, 1577 (Fed. Cir. 1984) (upholding as enabled a patent claim covering a class of explosive emulsions, forty percent of which were later found to be inoperable). On the other hand, because the enablement requirement depends in part on “the predictability or unpredictability of the art,” *In re Wands*, 858 F.2d 731, 737 (Fed. Cir. 1988) (listing predictability as one of eight factors), the enablement bar may be raised slightly when applied to inventions in new, unexplored fields.

198. MPEP, *supra* note 116, § 2113 (describing the “product-by-process” claim format).

application without building a working model.¹⁹⁹ Courts have also held that a patentee need not know or understand why his invention works.²⁰⁰ Indeed, a patentee need not even know for sure whether his invention is useful for the purpose disclosed in the specification.²⁰¹

b. Continuation Applications

In any event, patentees who need additional time to draft claims are protected by the availability of continuation applications.²⁰² At any time during the life of her patent, a patentee can file a continuation application in hopes of winning broader claims.²⁰³ Unlike the rarely used reissue proceeding, patentees frequently take advantage of continuations: Lemley and Moore found that twenty-three percent of all patents granted between 1976 and 2000, and fifty-two percent of all patents litigated during the same time period, issued from continuation applications.²⁰⁴ There is no limit on the number of continuations a patentee can file, and it is not rare for a sophisticated patent owner to keep a continuation application open during the entire life of her patent.²⁰⁵

Using (or perhaps abusing) the continuation process, it is surprisingly simple for a patentee to win claims covering products and technology introduced into the market well after her original

199. *Hoffman-La Roche, Inc. v. Promega Corp.*, 323 F.3d 1354, 1377 (Fed. Cir. 2003).

200. *See, e.g., Diamond Rubber Co. v. Consol. Rubber Tire Co.*, 220 U.S. 428, 435–36 (1911) (“A patentee may be baldly empirical, seeing nothing beyond his experiments and the result; yet if he has added a new and valuable article to the world’s utilities, he is entitled to the rank and protection of an inventor. And how can it take from his merit that he may not know all of the forces which he has brought into operation? It is certainly not necessary that he understand or be able to state the scientific principles underlying his invention . . .”); *Eames v. Andrews*, 122 U.S. 40, 55–56 (1887).

201. *See In re Brana*, 51 F.3d 1560, 1567–68 (Fed. Cir. 1995) (holding that a patent covering a compound structurally similar to effective chemotherapeutic agents satisfied the utility requirement even though the patented compound itself had not yet been proven effective in humans).

202. The availability of continuation applications has long been codified at 35 U.S.C. § 120 (2006). As a result of legislation passed in 2000, applicants can now prosecute a continuation without filing a new application. *See Request for Continued Examination Practice and Changes to Provisional Application Practice*, 65 Fed. Reg. 50,092, 50,093 (Aug. 16, 2000) (codified at 37 C.F.R. §§ 1.53(b), (d) (2010)). An inventor can also file a “continuation-in-part” application if she wishes to add new subject matter to her original application. 37 C.F.R. § 1.53(b). However, continuation-in-part applications may only claim priority back to the date of the original application for claims not arising from the added subject matter. *See* 35 U.S.C. § 132(a) (“No amendment shall introduce new matter into the disclosure of the invention.”).

203. Lemley & Moore, *supra* note 22, at 68.

204. *Id.* at 69.

205. *See* Lemley & Shapiro, *supra* note 25, at 78, 81.

application was filed. This practice, sometimes called “submarine patenting,”²⁰⁶ is possible because the continuation process ensures that a patentee can attempt to prosecute additional claims anytime before the original application expires. A savvy patentee can file an original application with a broad disclosure and patiently lie in wait for a competitor to introduce a successful product falling within the scope of the patent’s specification. The patentee can then file a continuation application and prosecute new claims targeting that later-developed product.²⁰⁷ The Federal Circuit has even embraced this practice, stating

there is nothing improper, illegal or inequitable in filing a patent application for the purpose of obtaining a right to exclude a known competitor’s product from the market; nor is it in any manner improper to amend or insert claims intended to cover a competitor’s product the applicant’s attorney has learned about during the prosecution of a patent application.²⁰⁸

4. Leniency for New Technology at the PTO

Further, there is good reason to believe that pioneers receive especially lenient treatment at the PTO. This leniency stems from the fact that the PTO is ill equipped to locate prior art in nascent fields.²⁰⁹ PTO examiners most often locate prior art in databases of issued patents. But, there will be few if any patents issued in a new, evolving field.²¹⁰ At best, when a potentially pioneering invention is made in an established scientific and technical area, prior art may exist in issues of academic and professional journals or in conference proceedings.²¹¹

206. Lemley & Moore, *supra* note 22, at 65.

207. Lemley & Shapiro, *supra* note 25, at 78 (“If the applicant is dissatisfied with the claims allowed by the patent examiner, the applicant can file a continuation application even after receiving a patent and thus continue to seek a patent with broader claims. . . . Applicants are even allowed to amend their applications to capture products that are appearing in the market, so long as they (arguably) stay within the bounds of the invention described in the initial application, which can be broad and rather vague.”).

208. *Kingsdown Med. Consultants, Ltd. v. Hollister, Inc.*, 863 F.2d 867, 874 (Fed. Cir. 1988) (en banc).

209. Note, *supra* note 120, at 2171 (“Although emerging technologies, by definition, contain less prior art, the PTO often misses entirely the prior art that does exist. In some cases, the PTO fails to discover prior art because it lacks the resources or the expertise to keep up in a rapidly changing field.”); *see also* Cohen & Lemley, *supra* note 193, at 43 (“The patent system presumes a finite, comprehensively indexed technical literature and relies on individual examiners to define, access, and search the relevant subliterations.”).

210. *See* Note, *supra* note 120, at 2171 (“For emerging technologies, a search through a database of existing patents will yield very little prior art.”).

211. Cohen & Lemley, *supra* note 193, at 42 (explaining that “innovation tak[ing] place outside traditional research institutions” will often be “recorded in ways that tend to elude

At worst, when the invention relates to an area like software, finance, or e-commerce that falls outside the interests of the established research community, what little prior art exists is unlikely to have been published in printed form at all.²¹² Given the diffuse nature of prior art in new fields and the time pressure examiners feel to slog through an increasing backlog of applications,²¹³ it may simply be impossible for the PTO to accurately assess the novelty of particularly cutting-edge inventions. As a result, pioneers' broad claims are unlikely to be rejected by the PTO in light of prior art. Consequently, pioneers are far less likely than ordinary applicants to amend their claims during prosecution and, therefore, less likely to suffer from the effect of prosecution history estoppel later in litigation.²¹⁴

5. Positive Externalities Discourage Litigation Against Pioneers

It is also unlikely that pioneer patents will face multiple challenges from competitors because patent challenges generate positive externalities. When an accused infringer successfully limits, invalidates, or renders a patent unenforceable in litigation, all market participants benefit because they are free to use the invention without restriction.²¹⁵ Because a firm challenging a patent bears the full cost of

the formal system of technical documentation" whereas "in fields more closely linked to the scientific and technical establishment" innovation is "typically . . . documented in peer-reviewed professional journals, conference abstracts, and the like").

212. *Id.* ("[S]oftware innovations . . . may be documented only via developer specifications or online FAQs. Frequently, the source code itself is never released at all."); see also Margo A. Bagley, *Internet Business Model Patents: Obvious by Analogy*, 7 MICH. TELECOMM. & TECH. L. REV. 253, 279–80 (2000) ("Commercial business models of the type that are being applied to the Internet, are likely, if anything, to be less well documented than financial methods. There simply is no real scientific literature on business models."); Josh Lerner, *Where Does State Street Lead? A First Look at Finance Patents, 1971–2000*, 57 J. FIN. 901, 905 n.5, 926 (2002) (finding that finance patents have on average eight times more citations to academic papers than patents covering inventions related to chemistry, energy, instrumentation, microbiology, and surgery).

213. On average, a patent examiner will spend just eighteen hours total on each application he reviews. See Mark A. Lemley, *Rational Ignorance at the Patent Office*, 95 NW. U. L. REV. 1495, 1500 (2001). At the close of 2009, the PTO employed just over 6,000 examiners and faced a backlog of more than 700,000 applications awaiting their first office action. *Patent Inventory Statistics—FY09*, U.S. PATENT & TRADEMARK OFFICE, <http://www.uspto.gov/patents/stats/appbacklog.jsp> (last modified Oct. 7, 2009).

214. See Bagley, *supra* note 212, at 282; Cohen & Lemley, *supra* note 193, at 43–44. Under the doctrine of prosecution history estoppel, patentees are precluded from asserting later in litigation that their claims cover subject matter they disclaimed during prosecution to avoid prior art or overcome some concern affecting patentability. See Lichtman, *supra* note 114, at 153.

215. See Joseph Farrell & Robert P. Merges, *Incentives to Challenge and Defend Patents: Why Litigation Won't Reliably Fix Patent Office Errors and Why Administrative Patent Review Might Help*, 19 BERKELEY TECH. L.J. 943, 958 (2004) ("[A] challenger

litigation but shares the benefit of invalidating or limiting the patent with its competitors, a company hoping to enter a pioneer-dominated market actually has little incentive to take on the pioneer.²¹⁶ Further, empirical evidence reveals that the most litigated patents of all are not broad patents guarding a technological field; instead they are predominantly weak, software patents held by non-practicing entities.²¹⁷

6. First Mover Advantages

Finally, initial patent rights aside, pioneer inventions have a natural advantage in the race to design and claim next-generation technology. Because pioneers by definition open up a new market, they are well positioned to exploit their position as the first player in the market they created. Empirical studies have shown that, like patent rights, first mover advantages encourage innovation. Some studies have even found that in certain industries first mover advantages are more effective than patent rights.²¹⁸ Pioneers will likely be the first to offer a product in their market and, accordingly, have a head start constructing production and distribution infrastructure and establishing brand loyalty.²¹⁹ In some industries, pioneers may be able to establish industry standards that further

bears the cost of litigation but its rivals and downstream buyers will capture almost all the benefits of successful challenge . . ."); Lemley & Shapiro, *supra* note 25, at 88; Shapiro, *supra* note 3, at 119.

216. See Farrell & Merges, *supra* note 215, at 958.

217. John R. Allison, Mark A. Lemley & Joshua Walker, *Patent Quality and Settlement Among Repeat Patent Litigants*, 99 GEO. L.J. 677, 680, 692, 695–96 (2011) (studying patents litigated eight or more times and finding that (1) suits enforcing such patents are successful only 10.7% of the time when litigated to a final resolution, (2) 63.5% of such patents are owned by non-practicing entities, and (3) 74.1% of such patents are software-related).

218. Stuart J.H. Graham et al., *High Technology Entrepreneurs and the Patent System: Results of the 2008 Berkeley Patent Survey*, 24 BERKELEY TECH. L.J. 1255, 1290 (2010) (finding in a survey of start-up companies that first mover advantage was the most “important” means to “capture competitive advantage” in the medical device and software industries); Richard C. Levin et al., *Appropriating the Returns from Industrial Research and Development*, 3 BROOKINGS PAPERS ON ECON. ACTIVITY 783, 816 (1987) (finding that “[l]ead time . . . [s]ecrecy, learning advantages, and sales and service efforts . . . are typically more important than the patent system”); Wesley M. Cohen, Richard R. Nelson & John P. Walsh, *Protecting Their Intellectual Assets: Appropriability Conditions and Why U.S. Manufacturing Firms Patent (Or Not)* 1 (Nat’l Bureau of Econ. Research, Working Paper No. 7552, 2000) (finding in a 1994 survey of 1,478 R&D labs that “patents tend to be the least emphasized . . . and secrecy and lead time tend to be emphasized most heavily”).

219. See sources cited *supra* note 218.

cement their dominant market position.²²⁰ As first movers, pioneers will have ample lead time in developing and patenting improvements and related products or services, which in many cases may become more profitable than the original invention.²²¹

B. Broad Pioneering Rights Reduce Overall Innovation

Next, contrary to assertions of pioneer doctrine advocates, extending broad patent rights to inventors in a nascent market will not increase overall innovation. In fact, the history of innovation is filled with counterexamples where broad patents quite clearly stifled innovation for years.

1. Broad Pioneer Scope Has Little Impact Ex Ante

Supporters of the pioneer doctrine can point to very little evidence that innovators have failed to pursue potentially pioneering inventions with less than optimal zeal. Virtually every innovation commonly recognized as a pioneer was independently invented by two or more inventors working at roughly the same time to solve the same known problem. Rather than expanded patent scope, by some metrics these pioneers should have received no patent rights at all. In any event, the pioneer doctrine can have at most a miniscule effect on inventors' ex ante decision making.

a. History Shows Intense Rivalry to Patent Supposed "Pioneers"

For almost a century when setting out the pioneer invention doctrine, courts stated that "[c]onspicuous examples of pioneer patents are those to Howe of the sewing machine, to Morse of the electrical telegraph and to Bell of the telephone."²²² Each of these three inventions was the subject of a highly publicized and contentious battle for patent rights.

Elias Howe fired the first shot in what became known as the "Sewing Machine War" by filing suit in 1852 against I.M. Singer &

220. See Lemley, *supra* note 73, at 1066–67.

221. For example, Jack Kilby of Texas Instruments, inventor of the first integrated circuit, also invented the first handheld calculator using integrated circuit technology. T.R. REID, *THE CHIP: HOW TWO AMERICANS INVENTED THE MICROCHIP AND LAUNCHED A REVOLUTION* 166–71 (2001).

222. *S. Saw Serv., Inc. v. Pittsburgh-Erie Saw Corp.*, 239 F.2d 339, 345 (5th Cir. 1956) (citing *Boyden Power Brake Co. v. Westinghouse*, 170 U.S. 537, 562 (1898)); see also *Ajinomoto Co. v. Archer-Daniels-Midland Co.*, No. 95-218-SLR, 1998 WL 151411, at *44 (D. Del. 1998) (citing *Boyden Power Brake Co. v. Westinghouse*, 170 U.S. 537, 562 (1898)).

Co., which in 1850 sold the first practical sewing machine incorporating the prior inventive efforts of John Bachelder (who improved on the designs of Charles Morey and Joseph B. Johnson), Sherburne C. Blodgett and J.H. Lerow, Allen B. Wilson, and Isaac Merritt Singer himself.²²³ The logjam of litigation that ensued among Howe, Singer, and the rest of the sewing machine industry over patent rights to the sewing machine was only broken by the creation of the first patent pool in U.S. history, the Sewing Machine Combination,²²⁴ a commercial trust reviled in its time for charging “ruinous” prices and employing a “‘number of lobbyists’ to obtain improper extensions of [its] patents.”²²⁵ By the time his patent expired in 1867, Howe had amassed more than two million in royalties without ever manufacturing a single sewing machine.²²⁶

Morse and Bell also won patent rights only after years of litigation. Morse’s rights to the telegraph were not at all clear until the Supreme Court ruled in his favor in 1854.²²⁷ Despite acknowledging great inventive rivalry among “many eminent and scientific men in Europe, as well as in this country,” brought on by widespread “belief that an electro-magnetic telegraph was practicable,”²²⁸ the Court upheld Morse’s patent over evidence of near-simultaneous invention in the mid-to-late 1830s by Charles Wheatstone and Sir William Fothergill Cooke, Joseph Henry, Edward Davy, and Carl August von Steinheil.²²⁹

Bell likewise won patent rights to the telephone only after a long-running legal battle that culminated in twelve days of argument before the Supreme Court and a disposition that fills an entire volume of the United States Reports.²³⁰ Noting that by the time of

223. See Adam Mossoff, *The Rise and Fall of the First American Patent Thicket: The Sewing Machine War of the 1850s*, 53 ARIZ. L. REV. 165, 171–82 (2011) (detailing the various patented inventions that led to the design of the first successful sewing machine); see also *id.* at 184–85 (discussing early negotiations between Howe and Singer, and Howe’s decision to pursue litigation in 1852). During litigation, attorneys for Singer discovered prior work by a prolific inventor named Walter Hunt, who allegedly invented a sewing machine with a shuttle and eye-point needle in 1834, ten years prior to Howe. See *id.* at 187.

224. See *id.* at 194–97.

225. See *id.* at 198 (quoting a “correspondent” to the *Philadelphia Enquirer*); see also *id.* at 197 (quoting contemporary descriptions of the Sewing Machine Combination as a “grinding, pitiless monopoly” engaging in “oppressive conduct”).

226. See *id.* at 193.

227. *O’Reilly v. Morse*, 56 U.S. (15 How.) 62, 124 (1854).

228. *Id.* at 107.

229. *Id.* at 110–11.

230. *The Telephone Cases*, 126 U.S. 1 (1888); John F. Duffy, *Rethinking the Prospect Theory of Patents*, 71 U. CHI. L. REV. 439, 461–62 (2004) (recounting the rivalrous

Bell's work "[i]t had long been believed that . . . the vibrations of air caused by the voice in speaking could be reproduced at a distance by means of electricity,"²³¹ the Court ruled—by a single vote—that Bell's patent held priority over the rights of numerous contemporaneous inventors.²³² Among them were Phillip Reis, who invented a device for reproducing tones at a distance more than a decade before Bell's invention and named his device the "telephone,"²³³ Elisha Gray and Thomas Edison, both of whom independently filed patent caveats on or before the day Bell's application was filed,²³⁴ and Daniel Drawbaugh, whose claim for priority Justice Bradley called "overwhelming" in dissent.²³⁵

These are not isolated examples. Other reputed pioneer inventions were, in fact, independently invented by multiple

invention of the telephone, including the fact that oral argument before the Supreme Court for *The Telephone Cases* "stretched over twelve days, and the report of the case fills an entire volume of the United States Reports").

231. *The Telephone Cases*, 126 U.S. at 532.

232. Justices Bradley, Field, and Harlan dissented and would have awarded priority to Daniel Drawbaugh. *Id.* at 573. Two Justices, Gray and Lamar, did not participate in the case. *Id.* at 577. Thus, Bell won priority over Drawbaugh by a vote of four to three.

233. *Id.* at 539–42.

234. See Duffy, *supra* note 230, at 462 ("Elisha Gray . . . filed a caveat for a telephone patent on the same day that Bell filed his patent application; Thomas Edison . . . began investigating telephone technology in 1875 and filed a patent caveat one month before Bell . . ." (footnote omitted)); see also *id.* at 462 n.88 ("[U]nder nineteenth-century patent practice; by filing a caveat, an inventor was entitled to notice from the Patent Office if any other inventor filed a patent application that seemed to cover the same invention. Once he received notice from the Patent Office, the inventor filing the caveat had three months to file a regular patent application . . ."). In fact, a number of scholars believe Bell may have borrowed from Gray's design. See, e.g., TIM WU, *THE MASTER SWITCH* 18 (2010) (noting "the testimony of a patent examiner, Zenas F. Wilbur, who admitted to accepting a \$100 bribe to show Gray's design to one of Alexander Bell's lawyers").

Bell's victory was made even more improbable by the fact that Bell's application was filed by Gardiner Hubbard, Bell's American business partner, without Bell's knowledge. ROBERT V. BRUCE, *BELL: ALEXANDER GRAHAM BELL AND THE CONQUEST OF SOLITUDE* 159, 168 (1990); see also GRAY, *supra* note 1, at 121 (noting that Bell "was furious with Hubbard for taking matters into his own hands"). Months earlier, Bell had arranged for his Canadian investor George Brown to file for a patent in Britain. GRAY, *supra* note 1, at 121. Because filing in the United States would jeopardize his British application, Bell promised Brown he would not apply for patent protection in the United States until after he had been awarded a British patent. BRUCE, *supra*, at 159. Bell was doubly lucky. Brown lost interest in the telephone and unilaterally chose not to file the British application that Hubbard's miraculous U.S. filing would have imperiled. GRAY, *supra* note 1, at 121. Bell later obtained a British patent and entered the British market with another investor, William H. Reynolds. *Id.* at 169.

235. *The Telephone Cases*, 126 U.S. at 573 (Bradley, J., dissenting). Oddly enough, in 2002, the House of Representatives passed a resolution naming another man, the Italian-American inventor Antonio Meucci, the inventor of the telephone. H.R. Res. 269, 107th Cong. (2002) (enacted).

competitors at virtually the same time. The list of well-documented examples is long²³⁶ and includes the microscope,²³⁷ the telescope,²³⁸ the thermometer,²³⁹ the sextant,²⁴⁰ the light bulb,²⁴¹ radio,²⁴² photography,²⁴³ television,²⁴⁴ the typewriter,²⁴⁵ the triode,²⁴⁶ the

236. William F. Ogburn and Dorothy Thomas identified 148 examples of independent discovery as of the turn of the twentieth century, though many are of unpatentable natural laws and phenomena. William F. Ogburn & Dorothy Thomas, *Are Inventions Inevitable? A Note on Social Evolution*, 37 POL. SCI. Q. 83, 93–98 (1922). Robert Merton and Elinor Barber identified 264 instances. Robert K. Merton & Elinor Barber, *Singletons and Multiples in Science*, in THE SOCIOLOGY OF SCIENCE: THEORETICAL AND EMPIRICAL INVESTIGATIONS 364, 364–65 (1979); see also JOSEPH ROSSMAN, THE PSYCHOLOGY OF THE INVENTOR: A STUDY OF THE PATENTEE 142 (2d ed. 1931) (listing twenty-eight examples); BERNHARD J. STERN, SOCIAL FACTORS IN MEDICAL PROGRESS 111–27 (Columbia Univ. Political Sci. Dep't ed. 1927) (identifying 150 instances of multiple invention in the medical arts); Mark A. Lemley, *The Myth of the Sole Inventor* 8–31 (2011) (unpublished manuscript) (on file with the North Carolina Law Review) (discussing the surprisingly cumulative nature of fifteen “pioneering inventions”).

237. Ogburn & Thomas, *supra* note 236, at 96 (listing Johannides, Drebbel, and Galileo as inventors in the early seventeenth century).

238. *Id.* (listing four independent inventions between 1608 and 1609).

239. *Id.* (listing eight independent inventions between 1606 and 1617).

240. *Simultaneous Discoveries Not Rare. Coincidences in History that Resemble Peary-Cook Exploit*, N.Y. TIMES, Sept. 12, 1909, at 9, available at <http://query.nytimes.com/mem/archive-free/pdf?res=F20B11FF3F5C15738DDDAB0994D1405B898CF1D3> (noting three independent inventors between 1729 and 1731).

241. See, e.g., Duffy, *supra* note 230, at 463 & n.94 (noting that “at least a half-dozen researchers were seeking the invention [of the incandescent light bulb] in the late 1870s,” including “Charles F. Brush, Moses Farmer, William E. Sawyer, Albon Man, J.W. Starr, Hiram Maxim, Joseph W. Swan, and St. George Lane-Fox”).

242. See BOLDRIN & LEVINE, *supra* note 11, at 203–06 (discussing numerous individuals other than Marconi who had achieved, or were close to achieving, the wireless transmission of radio signals between 1896 and 1898, including Oliver Lodge, Nikola Tesla, Aleksander Popov, Henry B. Jackson, and Ernest Rutherford).

243. Ogburn & Thomas, *supra* note 236, at 96 (listing Daguerre-Niepe and Talbot as independent inventors of photography in 1839, and Cros and Du Hauron as independent inventors of color photography in 1869).

244. See SAMUEL HANDEL, THE ELECTRONIC REVOLUTION 68–72 (1967) (documenting the 1920s competition between Vladimir Zworykin and Philo T. Farnsworth to perfect black and white television). The patent interference actions that ensued between Zworykin and Farnsworth additionally involved priority claims by five other inventors. See *McCreary v. Zworykin*, 55 F.2d 445, 447 (C.C.P.A. 1932); R.W. BURNS, TELEVISION: AN INTERNATIONAL HISTORY OF THE FORMATIVE YEARS 381–82 (B. Bowers ed. 1998). Neither was the first to build a working television system. That accomplishment went to John Logie Baird, who conducted the first public demonstration of televised images in London in January 1926. BURNS, *supra*, at 3, 163–64; WU, *supra* note 234, at 136–37 (noting also that Baird was followed “[a]lmost immediately” by Charles Francis Jenkins in the United States).

245. Ogburn & Thomas, *supra* note 236, at 98 (listing Beach, Sholes, and Wheatstone as independent inventors of the typewriter in the mid-nineteenth century).

246. See *Radio Corp. of Am. v. Radio Eng'g Labs.*, 293 U.S. 1, 2–7 (1934) (detailing the interference between Edwin H. Armstrong and Lee De Forest); see also GEORGE H. DOUGLAS, THE EARLY DAYS OF RADIO BROADCASTING 12 (1987) (calling the dispute

integrated circuit,²⁴⁷ the laser,²⁴⁸ x-ray imaging,²⁴⁹ the internal combustion engine,²⁵⁰ the diesel engine,²⁵¹ the cotton gin,²⁵² the reaper,²⁵³ the steamboat,²⁵⁴ the airplane,²⁵⁵ the jet engine,²⁵⁶ polypropylene,²⁵⁷ the reduction of aluminum,²⁵⁸ and vulcanized rubber.²⁵⁹

over the De Forest patent “one of the biggest and most controversial litigations in American history”).

247. See REID, *supra* note 221, at 110–17 (documenting the near simultaneous independent invention of the integrated circuit by Jack Kilby (in September 1958) and Robert Noyce (in January 1959) and the ensuing litigation between Texas Instruments and Fairchild Semiconductor over patent rights to the invention).

248. See generally NICK TAYLOR, *LASER: THE INVENTOR, THE NOBEL LAUREATE, AND THE THIRTY-YEAR PATENT WAR* (2000) (documenting the independent invention of the laser by Gordon Gould (in November 1957) and Charles Townes and Arthur Schawlow (in February 1958) and ensuing litigation over patent rights to the invention). Neither was the first to create a working laser. Theodore Maiman built the first laser using ruby crystal in 1960. See *id.* at 194.

249. LAMB & EASTON, *supra* note 2, at 173–74 (noting that A.W. Goodspeed and W.J. Jennings took the first x-ray photograph six years before Willhelm Konrad Röntgen “discovered” x-ray technology in 1895).

250. See, e.g., MERGES, *supra* note 159, at 644 (“In the last quarter of the nineteenth century, the efforts of many inventors in a number of countries developed the internal combustion gasoline engine . . . [M]any people independently thought of the idea as soon as the most primitive gasoline engines were developed.”).

251. LAMB & EASTON, *supra* note 2, at 126 (noting that Rudolf Diesel patented his engine design in 1892, after H. Akroyd Stuart developed a similar design in 1890).

252. Lemley, *supra* note 236, at 11–12 (noting that Eli Whitney was not the only inventor to develop a “toothed” gin in the 1790s).

253. Ogburn & Thomas, *supra* note 236, at 98 (listing Hussey and McCormick as independent inventors in 1833 and 1834, respectively).

254. JACK L. SHAGENA, *WHO REALLY INVENTED THE STEAMBOAT?: FULTON’S CLERMONT COUP* 113–384 (2004) (considering eight candidates: William Henry, James Rumsey, John Fitch, Oliver Evans, Nathan Read, Samuel Morey, Robert Fulton, and John Stevens).

255. See, e.g., Mark A. Lemley, *Should Patent Infringement Require Proof of Copying?*, 105 MICH. L. REV. 1525, 1528 (2007) (“[T]he airplane . . . was first patented by the Wrights but independently developed and significantly improved upon by Glenn Curtis and others.”).

256. LAMB & EASTON, *supra* note 2, at 60 (“The first modern propellerless jet engines were conceived almost simultaneously in England [by Frank Whittle] and Germany [by Hans von Ohain and others] during the nineteen thirties.”).

257. See, e.g., Lemley, *supra* note 255, at 1528 (“[P]olypropylene . . . was the subject of a 30-year interference between competing inventors.”).

258. Ogburn & Thomas, *supra* note 236, at 96 (listing three independent inventors between 1885 and 1887).

259. Thomas Hancock coined the term “vulcanization” and filed for a patent in the United Kingdom eight weeks before Charles Goodyear, though some question remains whether Hancock’s discovery was completely independent. See HAROLD EVANS ET AL., *THEY MADE AMERICA* 100 (2004) (noting that Hancock allegedly had access to rubber samples circulated by Goodyear). See generally CHARLES SLACK, *NOBLE OBSESSION: CHARLES GOODYEAR, THOMAS HANCOCK AND THE RACE TO UNLOCK THE GREATEST*

The notion that certain valuable discoveries are not being pursued due to insufficient patent-related incentives is simply without empirical support. The surprisingly high incidence of near-simultaneous independent invention of technological breakthroughs²⁶⁰ should caution against extending greater rewards to whomever ultimately wins priority at the patent office. In fact, starting from the premise that a patentee should be rewarded with some fraction of the social value of his invention,²⁶¹ it follows that an inventor hoping to patent an invention independently reached by others at about the same time should receive no rights at all. When two inventors independently make the same discovery, “each inventor’s social contribution . . . is nil: the invention would have been available to society even if [one] inventor had not discovered the invention.”²⁶² Therefore, it could be argued, the appropriate reward

INDUSTRIAL SECRET OF THE NINETEENTH CENTURY (2002) (setting forth the history of the commercial development of rubber). The nascent auto-tire industry spawned numerous instances of multiple invention, including the tubeless tire and the use of carbon black. See LAMB & EASTON, *supra* note 2, at 175.

Other, non-patentable examples of multiple, independent invention include calculus, logarithms, use of the decimal point, the periodic table, the theory of relativity, the theory of natural selection, and the discovery of oxygen, sunspots, and the planet Neptune. Ogburn & Thomas, *supra* note 236, at 93–98 (listing many more examples). See generally Leo Corry, Jürgen Renn & John Stachel, *Belated Decision in the Hilbert-Einstein Priority Dispute*, 278 SCIENCE 1270 (1997) (examining priority issues regarding whom should be credited with conceiving the theory of relativity); Tony Rothman, *Lost in Einstein’s Shadow: Einstein Gets the Glory but Others Were Paving the Way*, 94 AM. SCIENTIST 112 (2006) (providing an account of Einstein’s contemporaries who did research on the theory of relativity).

260. Indeed, many believe that “multiple discovery is not exceptional but is the normal method by which scientific development proceeds.” LAMB & EASTON, *supra* note 2, at ix; see also *Kewanee Oil Co. v. Bicron Corp.*, 416 U.S. 470, 490 (1974) (“[I]f a particular individual had not made a particular discovery others would have, and in probably a relatively short period of time. If something is to be discovered at all very likely it will be discovered by more than one person.”); Shapiro, *supra* note 3, at 127 (“[I]n rapidly advancing fields such as information technology and biotechnology, . . . many applied ideas flowing from basic research are ‘in the air’ at any given time.”).

There appear to be very few instances in which one inventor made a singular breakthrough that was not being aggressively pursued by others. Chester Carlson’s invention of photocopying is one legitimate candidate. See Duffy, *supra* note 230, at 463–64.

261. Mark A. Lemley & Carl Shapiro, *Patent Holdup and Royalty Stacking*, 85 TEX. L. REV. 1991, 1999–2000 (2007) (defining benchmark-level compensation as a division of the value created by the patented invention).

262. Shapiro, *supra* note 3, at 116; see also Mark A. Lemley & Carl Shapiro, Reply, *Patent Holdup and Royalty Stacking*, 85 TEX. L. REV. 2163, 2166 (2007) (“[P]atent holders are generally overrewarded in situations where other parties independently achieve the same (or a similar) invention at roughly the same time”); Ogburn & Thomas, *supra* note 236, at 85 (“If the various inventors had died in infancy, would not the inventions have been made and would not cultural progress have gone on without much delay?”).

for whichever inventor wins priority equals the value he contributed to society: nil.²⁶³

b. The Pioneer Doctrine's Ex Ante Effect Is De Minimis

Even if history did not dispute the existence of truly pioneering inventions, the pioneer doctrine's impact on inventors' ex ante incentives is likely quite small. As an extension of the doctrine of equivalents, the pioneer doctrine primarily acts to expand the inventor's claim scope to capture new applications or improvements that the inventor could not have foreseen at the time she filed her patent application. It goes without saying that an inventor's ex ante incentive to invent will not be greatly enhanced by the possibility that years later her patent rights will possibly expand to cover some as-of-yet unforeseen future development. The doctrine's effect on a potential inventor's pre-invention decision making is diminished by a number of contingencies: the invention might never be adopted by the public; it might not lend itself to improvements; it might lend itself only to foreseeable improvement; it might give rise to unforeseeable improvements that the inventor has a natural advantage developing; or it might give rise to improvements so advanced that the reverse doctrine of equivalents will apply to take ownership away from the inventor regardless.²⁶⁴ In other words, viewed ex ante, the pioneer doctrine is so unlikely to matter that it could have at most a de minimis impact on innovation.²⁶⁵ Far more likely to spur groundbreaking innovation are the many natural advantages, discussed above, that pioneers have over their late-comer competitors.²⁶⁶

Empirical evidence shows that even drastic increases in the potential breadth of patent scope may not induce much additional

263. Though few, if any, scholars would champion this line of argument to such an extreme, many have argued in favor of an independent invention defense that would permit independent inventors to practice their invention without fear of suit by an unknown prior inventor. See generally Samson Vermont, *Independent Invention as a Defense to Patent Infringement*, 105 MICH. L. REV. 475 (2006) (arguing that independent invention should be a defense against patent infringement).

264. See Merges, *supra* note 97, at 102 (making a similar point).

265. *Bur cf.* Dennis D. Crouch, *The Patent Lottery: Exploiting Behavioral Economics for the Common Good*, 16 GEO. MASON L. REV. 141 *passim* (2008) (analyzing the so-called "lottery effect" in patent law that leads many inventors to overestimate their likelihood of obtaining a very lucrative patent).

266. See Merges & Nelson, *supra* note 28, at 878 n.163 ("[R]educing scope at the margin will not completely eliminate the advantages of a pioneering invention over an improvement. Even without patents, pioneering inventions can lead to much higher returns than mere improvements.").

innovation. In 1988, Japan passed patent reform legislation allowing inventors to file multi-claim patent applications for the first time.²⁶⁷ Before that time, Japanese patents were strictly limited to one claim.²⁶⁸ Despite drastically increasing patentees' ability to claim near-equivalent embodiments of their inventions, these patent reforms failed to increase R&D spending or innovative output in Japan.²⁶⁹

2. Broad Pioneer Scope Discourages Innovation Ex Post

Just as there is no evidence that broad protection for pioneer patents spurs more innovation ex ante, there is also no evidence that broad pioneer patent scope facilitates the continued development and commercialization of inventions ex post. To the contrary, economic insight and historical experience suggest that broad pioneer patent rights impede, rather than hasten, the improvement and dissemination of valuable new inventions, which are often more important and commercially valuable than the early inventions on which they build.²⁷⁰

a. Dominant Firms Hold Up Improvers, Rather than Coordinate

Unlike the hypothetical coordinating firms of Kitch's prospect theory, history shows that firms achieving near monopoly over an industry with broad patent rights have not been good stewards of their intellectual property.²⁷¹ As discussed further below, pioneer

267. These reforms also included a term extension of up to five years for pharmaceutical inventions. Mariko Sakakibara & Lee Branstetter, *Do Stronger Patents Induce More Innovation? Evidence from the 1988 Japanese Patent Law Reforms*, 32 RAND J. ECON. 77, 78–79 (2001).

268. *Id.* at 79.

269. *Id.* at 98–99.

270. Christopher D. Hazuka, *Supporting the Work of Lesser Geniuses: An Argument for Removing Obstructions to Human Embryonic Stem Cell Research*, 57 U. MIAMI L. REV. 157, 188 (2002) (“[A]lthough pioneer inventions may be technologically or creatively impressive, it may be the improvements that are commercially successful.”); Lemley, *supra* note 73, at 997 (“[I]mprovements’ may in many cases dwarf the original work in terms of their practical significance . . .”); Robert P. Merges, *Rent Control in the Patent District: Observations on the Grady-Alexander Thesis*, 78 VA. L. REV. 359, 373 n.54 (1992) (“A study of the history of innovations in almost any field will show the key importance of improvement inventions.”).

271. A patent “monopoly,” of course, does not guarantee a monopoly in the true sense. See Alan Devlin, *The Stochastic Relationship Between Patents and Antitrust*, 5 J. COMPETITION L. & ECON. 75, 112 (2009) (“[P]atents rarely grant a monopoly in antitrust terms—that is, a patent will rarely cover a product that is of such unique value that no substitutes exist for it at competitive price levels . . .”). Nevertheless, a number of firms

firms tend to rest on their laurels or narrowly focus on one part of their technological “prospect” where they have expertise while ignoring other areas that might also be profitable.²⁷² For example, within a decade of perfecting the steam engine, James Watt wrote to his partner James Boulton:

On the whole I find it is now full time to cease attempting to invent new things, or to attempt anything which is attended with any risk of not succeeding, or of creating trouble in the execution. Let us go on executing the things we understand, and leave the rest to younger men, who have neither money nor character to lose.²⁷³

Indeed, some commentators have argued that large dominant firms by their very nature are ill suited to innovate.²⁷⁴ Further, instead of liberally licensing their patent rights to upstart competitors, dominant firms may instead engage in rent-seeking activities aimed at protecting their dominant market shares.²⁷⁵ Thomas Edison, for

have achieved near-monopoly status in certain industries by exercising broad patent rights. See Roberto Mazzoleni & Richard R. Nelson, *The Benefits and Costs of Strong Patent Protection: A Contribution to the Current Debate*, 27 RES. POL’Y 273, 275 (1998) (noting, in particular, AT&T’s near monopoly on telephone service and General Electric and Westinghouse’s near monopoly on light bulb production).

272. Merges & Nelson, *supra* note 28, at 872–73; see also Kenneth J. Arrow, *Economic Welfare and the Allocation of Resources for Invention*, in THE RATE AND DIRECTION OF INVENTIVE ACTIVITY 609, 620 (Nat’l Bureau of Econ. Research ed. 1962) (“[P]reinvention monopoly power acts as a strong disincentive to further innovation.”).

273. F.M. Scherer, *Invention and Innovation in the Watt-Boulton Steam-Engine Venture*, 6 TECH. & CULTURE 165, 174 (1965) (quoting Letter from James Watt to Matthew Boulton (Nov. 5, 1785)). Watt conceived of a steam engine with a “separate condensing vessel” in 1765, but did not perfect his improved design until after joining forces with Boulton in 1774. See *id.* at 167–69.

274. See, e.g., Jonathan M. Barnett, *Cultivating the Genetic Commons: Imperfect Patent Protection and the Network Model of Innovation*, 37 SAN DIEGO L. REV. 987, 1022–26 (2000); Arti K. Rai, *Fostering Cumulative Innovation in the Biopharmaceutical Industry: The Role of Patents and Antitrust*, 16 BERKELEY TECH. L.J. 813, 825 (noting that a large firm’s “hierarchical structure and culture may be inimical to innovation, or at least inimical to radical innovation”). On the innovative advantages small firms have over their large counterparts, see generally ZOLTAN J. ACS & DAVID B. AUDRETSCH, *INNOVATION AND SMALL FIRMS* (1990).

275. See MORTON I. KAMIEN & NANCY L. SCHWARTZ, *MARKET STRUCTURE AND INNOVATION* 29–30 (1982) (“[T]he firm presently realizing monopoly profits may be less motivated to seek additional profits than the one earning only normal profits. . . . [This is because] it may become more concerned with protecting its current monopoly position than acquiring a new one.”). These activities may include suppressing superior technologies. See WU, *supra* note 234, at 126–35 (discussing RCA’s efforts in the 1930s and 1940s to dissuade Edwin Armstrong from further developing FM radio because it threatened the large networks then dominating the AM airwaves); Mark Clark, *Suppressing Innovation: Bell Laboratories and Magnetic Recording*, 34 TECH. & CULTURE 516, 530–37 (1993) (detailing Bell Labs and AT&T’s efforts in the late 1930s and 1940s to

example, transitioned in less than a decade from pioneer of incandescent lighting “to a staunch opponent of the ‘dangerous’ innovation of alternating current.”²⁷⁶

We need not rehash the entire history of innovation, however, to see that it is impractical to expect pioneers and improvers to coordinate the development of existing technology. Simple economic intuition dictates that when an opportunity to develop an improvement arises, pioneers and improvers will frequently fail to reach an agreement, especially when the improvement at issue is of high value.

The reason is simple: the pioneer patent holder can use his patent rights to hold up the improver for much of the value of the proposed improvement. Consider a numerical example.²⁷⁷ Assume that a pioneer inventor holds patent rights covering a product that nets the pioneer \$100 in profits per sale. Predictably, the pioneer is unable on his own to imagine and develop all possible improvements to his patented product. Luckily, an improver foresees a valuable improvement to the pioneer’s technology that he believes could be embodied in an improved version of the pioneer’s product that will net a much larger profit of \$1,000 per sale. Because the improver cannot produce his product without infringing the pioneer’s patent, the improver must receive the pioneer’s permission to move forward with production. That is, the improver must offer the pioneer at least some portion of the \$900 surplus created by his improvement to bring his idea to fruition. Assuming the parties have approximately even bargaining power and agree to split the surplus evenly, the improver is left with just \$450 of reward for his improvement, while the pioneer accrues \$550 of the total allocation.²⁷⁸ Thus, even in a Coasean world

suppress the development of magnetic recording technology for everyday home use because they “feared that the availability of a recording device would make customers less willing to use the telephone system”); Richard Dunford, *The Suppression of Technology as a Strategy for Controlling Resource Dependence*, 32 ADMIN. SCI. Q. 512, 516 (1987) (discussing, among others, General Electric’s suppression of fluorescent lighting, and various oil companies’ alleged suppression of solar energy technology).

276. Merges & Nelson, *supra* note 28, at 872 n.141.

277. This example is substantially borrowed from Merges, *supra* note 97, at 79–81, and Merges & Nelson, *supra* note 28, at 866 n.117.

278. This negotiation will likely be impacted by the intellectual property rights held by the respective parties. In some situations, particularly when the original inventor’s rights are broad and the improvement is relatively small, the improver may not be able to secure a patent covering the improvement. In these cases, the improver is simply an infringer and has bargaining power only because he is aware of the improvement and the original inventor is not. To bargain effectively, such improvers must overcome “Arrow’s paradox of information,” which refers to the fact that in order to sell information a seller must

without transactions costs, broad patent rights covering an invention significantly reduce potential improvers' incentives to invest in further developing that invention.

The real world, of course, is not Coasean and, accordingly, transactions costs and strategic behavior will further conspire to sink many potential deals between existing patentees and improvers, unfortunately causing many valuable improvements to sit unused for years until their predecessors' patents expire.²⁷⁹ One major impediment to licensing between original inventors and improvers is divergent views of the value of the improvement. In the numerical example above, both the original patentee and improver agree that the improvement creates a \$900 surplus. In the real world, it is extraordinarily difficult to assess *ex ante* just how valuable a particular piece of technology will be.²⁸⁰ The history of modern technology is littered with examples of wildly inaccurate assessments. Marconi and Deforest, for example, predicted that radio would be

disclose his information to the potential buyer, who now possessing the information no longer needs to purchase it. Arrow, *supra* note 272, at 614–16. Trade secret law offers a partial solution, as do contractual provisions prohibiting the disclosure of certain information. See Lemley, *supra* note 73, at 1052 n.289. Often, however, the improvement will be independently patentable. In these situations, the original inventor and the improver are said to have “blocking patents.” See Merges, *supra* note 97, at 80. The original inventor can block the improver from selling a product embodying his basic invention, but the improver can likewise block the original inventor from selling a product embodying his new improvement. *Id.*

279. Some economists theorize that rational strategic behavior alone can lead to a bargaining breakdown even when a positive surplus is on the table. See, e.g., Robert Cooter & Stephen Marks, *Bargaining in the Shadow of the Law: A Testable Model of Strategic Behavior*, 11 J. LEGAL STUD. 225, 243 (1982) (“Rationality requires the players to adopt strategies in which they risk destroying the surplus in order to gain a larger share of the stakes in the event of settlement.”). Fields in which bargaining breakdown delayed the adoption of valuable improvements include steelmaking, see Merges, *supra* note 97, at 87–88 (discussing how blocking patents long delayed integration of the Bessemer-Kelly blast furnace and Robert Mushnet’s alloying compound speigeleisen), and chemical textile coloring, see BOLDRIN & LEVINE, *supra* note 11, at 91 (discussing Baadische Chemical Company’s inability to understand and implement Levinstein & Company’s improved chemical process after winning an injunction against Levinstein in England). On the general topic of incumbent patentees’ ability to exclude start-up competitors from the market, see Colleen V. Chien, *Of Trolls, Davids, Goliaths, and Kings: Narratives and Evidence in the Litigation of High-Tech Patents*, 87 N.C. L. REV. 1571, 1588 (2009); Stuart J.H. Graham & Ted Sichelman, *Why Do Start-Ups Patent?*, 23 BERKELEY TECH. L.J. 1063, 1080–81 (2008).

280. Lemley, *supra* note 73, at 1053 (“[W]hile the parties ideally would base the cost of a license on the value of the right licensed, that value will likely be difficult to determine accurately in the case of unique goods like intellectual property rights. This problem is exacerbated in the context of licensing potential improvements, since if it is hard to value an invention that has already been made, it is well-nigh impossible to value one that might be made in the future.”).

used only for point-to-point communication; neither foresaw commercial broadcasting as a viable application.²⁸¹ IBM likewise failed to foresee that there would be a commercial market for computers.²⁸² And the transistor was expected to make a splash primarily in the hearing aid market.²⁸³

Many commentators have also noted that difficulty in valuing the technological contribution of an improvement can lead inventors' emotional ties to their inventions to make their assessments diverge even further. Original inventors may be prone to assert a moral claim over the improvement, while an improver may tend to view her contribution as the keystone without which the technology would be worthless.²⁸⁴ If the addition of uncertainty and ego into the example above causes the original inventor to estimate that the improvement will net just \$700 in additional profit and the improver to overestimate the surplus as \$1,100, the parties may well fail to reach a bargain because neither will be willing to accept what the other views as a fair offer.²⁸⁵

Finally, transactions costs will deplete the potential surplus of some percentage of potential licenses. The negotiation of patent licenses is notoriously expensive, with some estimating costs at twenty percent of the total royalty payment.²⁸⁶ To obtain a license, a

281. See DOUGLAS, *supra* note 246, at 2 (“[In 1920,] RCA . . . wasn’t the slightest bit interested in radio broadcasting as we think of it today.”); Lemley, *supra* note 73, at 1050 n.281.

282. See Merges, *supra* note 97, at 86 n.41.

283. See Lemley, *supra* note 73, at 1050 n.281. Other examples include the VCR, which was initially marketed to TV stations for airing reruns, see Merges, *supra* note 97, at 86 n.42, and the telephone, which was initially viewed as a curiosity that would never replace the telegraph, see GRAY, *supra* note 1, at 129 (quoting a Western Union electrician, who wrote that the “telephone has too many shortcomings to be seriously considered as a means of communication” and had “no value to us.”); WU, *supra* note 234, at 25 (noting that Western Union turned down Bell’s offer to sell his telephone patents for \$100,000).

284. See Merges, *supra* note 97, at 90–91. Further, original inventors may refuse to license their rights to potential improvers for any number of other “irrational” reasons. Lemley, *supra* note 73, at 1060–61. See generally Christopher Buccafusco & Christopher Sprigman, *The Creativity Effect*, 78 U. CHI. L. REV. 31 (2011) (showing the existence of an additional, distinct “creativity effect”); Christopher Buccafusco & Christopher Sprigman, *Valuing Intellectual Property: An Experiment*, 96 CORNELL L. REV. 1 (2010) (demonstrating the existence of an “endowment effect” even in transactions involving non-rival creative works).

285. See Lemley, *supra* note 73, at 1055–56 (developing a similar example). Assuming equal bargaining power, the improver will view an offer of \$550 as a reasonable division, whereas the original inventor will aim to settle for about \$350 per unit. See *id.* at 1062 (describing a similar hypothetical).

286. DAVID J. TEECE, *THE MULTINATIONAL CORPORATION AND THE RESOURCE COST OF INTERNATIONAL TECHNOLOGY TRANSFER* 43–44 (1976); see also FAROK J.

potential improver must determine what existing technology rights he needs to license, find out who owns those rights, and negotiate a royalty payment. None of these steps is trivial. The PTO has issued more than 140,000 patents per year since 1998 and inventors have filed more than 450,000 new applications each year since 2007.²⁸⁷ To even determine whom to approach, an improver would theoretically have to review the many thousands of patents issued in his industry in the previous two decades and, even if an improver paid to search for and review all relevant existing patents, it is unlikely he would be able to say with any certainty exactly which patents he should license because it is extraordinarily difficult to determine the scope of patent claims.²⁸⁸ Further, licenses themselves are frequently complex agreements drafted by lawyers, and many specify ongoing royalty payments that impose additional monitoring costs on both parties.²⁸⁹

b. Pioneer Patents by Industry

Combining historical results with economic intuition, it becomes even more apparent that broad pioneer rights hinder innovation, regardless of market characteristics. As noted above, several scholars have suggested that the pioneer doctrine might play a beneficial role in at least some markets.²⁹⁰ However, the pioneer doctrine is unlikely to spur innovation in any industry. In two broad categories—industries in which innovation is primarily cumulative or competitive—the costs of the pioneer doctrine certainly exceed its

CONTRACTOR, INTERNATIONAL TECHNOLOGY LICENSING 101–05 (1981) (finding costs of \$192,000 per transaction in a study of seventy-three transactions between U.S. licensors and international licensees located in countries with “industrialized-market economies”).

287. *U.S. Patent Statistics Chart Calendar Years 1963–2010*, *supra* note 90.

288. See Brian J. Love, *The Misuse of Reasonable Royalty Damages as a Patent Infringement Deterrent*, 74 MO. L. REV. 909, 936–39 (2009). Even if patent claims were always written in the plainest language, no amount of analysis can protect an improver from a patentee with “a continuation application waiting in the wings” to capture her improvement. Lemley & Shapiro, *supra* note 25, at 78, 82.

289. See Lemley, *supra* note 73, at 1053 (citing JAY DRATLER, JR., LICENSING OF INTELLECTUAL PROPERTY §§ 1.01(2), 1.04(1) (1996)).

290. Merges and Nelson, and Burk and Lemley have studied patent law’s effects across industries. Merges and Nelson categorized industries as discrete, cumulative, chemical, or “science-based.” Merges & Nelson, *supra* note 28, at 880. Burk and Lemley matched industries with five economic theories of patent protection: prospect theory, competitive innovation, cumulative innovation, anticommons theory, and patent thickets. Burk & Lemley, *Policy Levers*, *supra* note 9, at 1615–30. The analysis that follows merges the analysis of both studies and considers cumulative, competitive, discrete, and the pharmaceutical/biomedical industries. The analysis of the pharmaceutical and biomedical industries draws from Merges and Nelson’s insights on the chemical and science-based industries, as well as Burk and Lemley’s analysis of industries that map to the anticommons and patent thicket theories.

benefits. In a third, those where innovation is discrete, the doctrine will have virtually no effect. Finally, contrary to the most recent calls for the pioneer doctrine's revival, the pioneer doctrine is unlikely to benefit even the pharmaceutical and biomedical industries.

i. Cumulative

In many industries, virtually all innovation builds incrementally upon existing technology. This type of "cumulative" advance is the norm, for example, in industries that produce complex products made from many components, many of which themselves are quite complicated and composed of many subparts.²⁹¹ Such products include cars, airplanes, and computer hardware.²⁹² Due to the technological complexity inherent in these industries, innovation tends to advance not as the result of sweeping paradigm shifts but rather as the result of improvements to discrete components or the introduction of new components. Thus, extending broad patent rights to an early pioneer inventor of a complex system confers substantial power on the inventor to control a large technological prospect. As a result, the inability or unwillingness of the pioneer to license to potential improvers hoping to advance any one of the many components can effectively freeze innovation in the industry for years.

Historical evidence bears out that in cumulative industries the inability of dominant pioneers and improvers to coordinate has hampered growth in many areas. The early market for electrical lighting provides one such example.²⁹³ Once validated in 1891, Edison's pioneering incandescent lamp patent gave Edison's company (which would later become General Electric) a near monopoly on incandescent lamp production.²⁹⁴ Instead of coordinating with competitors to further develop lighting technology, Edison used his patent rights to quickly eliminate as much competition as possible. Between 1891 and 1894, Edison's market

291. See Merges & Nelson, *supra* note 28, at 881–82, 884–97 (discussing "cumulative" industries and the effect of broad patent scope in such industries).

292. *Id.* at 881.

293. *Id.* at 885–88 (detailing General Electric's domination of the nascent electrical lighting industry).

294. *Edison Elec. Light Co. v. U.S. Elec. Lighting Co.*, 52 F. 300, 314 (2d Cir. 1892) (affirming the Southern District of New York's 1891 ruling upholding the validity of Edison's U.S. Patent No. 223,898).

share grew from forty to seventy-five percent.²⁹⁵ At the same time, the rate of innovation in the industry slowed to a standstill. With the market secured, Edison turned his attention to other inventions.²⁹⁶ Not until after Edison's pioneering patent expired and the company's market share began to decline did General Electric begin to invest in improving its lamp technology.²⁹⁷

Watt's domination of the late-eighteenth century market for steam engines in the United Kingdom is a similar story. Initially awarded patent rights in 1769, Watt made little effort to produce an engine until 1775 when, thanks to the political connections of his business partner Matthew Boulton, Parliament extended Watt's patent rights to 1800.²⁹⁸ With his rights extended, Watt asserted his patent aggressively against rivals, thwarting the efforts of improvers like Jonathan Hornblower, who invented a more efficient "compound engine" with two cylinders, and Richard Trevithick, inventor of the "high pressure" steam engine.²⁹⁹ Evidence that Watt's broad patent rights delayed, rather than spurred, the industrial revolution is quite convincing. During the term of Watt's patent, the United Kingdom added just 750 horsepower of engine capacity per year and made little improvement in engine fuel capacity.³⁰⁰ After Watt's rights expired and improved engines became available, that rate jumped to more than 4,000 horsepower annually and fuel efficiency quintupled.³⁰¹

295. See Merges & Nelson, *supra* note 28, at 885–86 (citing ARTHUR A. BRIGHT, JR., *THE ELECTRIC-LAMP INDUSTRY: TECHNOLOGICAL CHANGE AND ECONOMIC DEVELOPMENT FROM 1800 TO 1947*, at 91–92 (1949)).

296. See ARTHUR A. BRIGHT, JR., *THE ELECTRIC-LAMP INDUSTRY: TECHNOLOGICAL CHANGE AND ECONOMIC DEVELOPMENT FROM 1800 TO 1947*, at 122 (1949).

297. *Id.* at 138–39.

298. BOLDRIN & LEVINE, *supra* note 11, at 1.

299. *Id.* at 3–4, 12 n.5. Perhaps appropriately so, Watt's engine was less efficient than it could have been because Watt was unable to license James Pickard's patented "crank and flywheel" and, thus, had to improvise his own alternative gear. *Id.* at 2.

300. *Id.* at 1.

301. *Id.* To give one more example, in the earliest days of radio, Marconi Wireless and Telegraph Company, which dominated the industry with its patent on the diode, refused to license its rights to AT&T, which hoped to produce radio equipment using the newly-invented triode. See Merges & Nelson, *supra* note 28, at 891–93 (detailing the conflict in the early radio industry among Marconi, AT&T, General Electric, Westinghouse, and other companies). As a result, the triode sat unused for a number of years until just after World War I, when the U.S. Navy facilitated the consolidation of the radio industry's fundamental patent rights in the newly formed Radio Corporation of America ("RCA"). See FED. TRADE COMM'N, REPORT OF THE FEDERAL TRADE COMMISSION ON THE RADIO INDUSTRY: IN RESPONSE TO HOUSE RESOLUTION 548, 67th Cong., 4th Sess., Dec. 1, 1923, at 18–21, 26–27 (1924).

Pioneers have used their patents in other ways to impede the progress of other cumulative technology industries. Selden, the pioneer inventor of the gasoline-powered internal combustion engine,³⁰² never again sought to advance improvement in the automobile industry and instead devoted his efforts exclusively to extracting royalties from those, including Henry Ford, who did.³⁰³ Taking the opposite approach, the Wright brothers sought to advance the aircraft industry single-handedly and fought tooth and nail to exclude other legitimate innovators from the market until the Secretary of the Navy intervened during World War I to force cross-licensing.³⁰⁴

In contrast to these examples, innovation has often been rapid in industries without a powerful pioneer. The rise of the computer industry in the twentieth century, for example, may be attributable in part to the fact that the industry narrowly dodged single firm domination at two pivotal moments in its history: first, when an antitrust suit filed shortly after the invention of the transistor forced AT&T to license its patent rights at low rates³⁰⁵ and, second, when Texas Instruments and Fairchild Semiconductor each denied the other sole control of the integrated circuit by winning patent rights covering basic aspects of that technology.³⁰⁶

ii. Competitive

In other industries, innovation occurs without widespread use of the patent system. In these industries, competition in the marketplace—usually in conjunction with other factors like relatively low R&D costs and powerful first mover advantages—is a sufficient

302. Selden, a patent attorney by trade, kept his patent in prosecution for sixteen years. When it finally issued (much to the surprise of the maturing automobile industry), John Seymour, the Commissioner of Patents, dubbed it “the pioneer invention in the application of the compression gas engine to road or horseless carriage use.” See WILLIAM GREENLEAF, *MONOPOLY ON WHEELS: HENRY FORD AND THE SELDEN AUTOMOBILE PATENT* 38, 49–50 (1961).

303. See *id.* at 106–11 (detailing Selden’s efforts to assert his rights against Ford and others); see also BOLDWIN & LEVINE, *supra* note 11, at 84 (“Once Selden’s patent, no. 549,160, was awarded, it commanded royalties of 1.25 percent on the sale value of every automobile sold in the United States.”).

304. Merges & Nelson, *supra* note 28, 890–91 (citing *Wright Co. v. Herring-Curtiss Co.*, 204 F. 597, 614 (W.D.N.Y. 1913), *aff’d*, 211 F. 654 (2d Cir. 1914)).

305. *Id.* at 893–94 (citing Richard C. Levin, *The Semiconductor Industry*, in *GOVERNMENT AND TECHNICAL PROGRESS* 76 (Richard Nelson ed., 1982)).

306. See generally REID, *supra* note 221 (discussing the history of both Texas Instruments and Fairchild Semiconductor and their role in developing the integrated circuit).

spur to innovation.³⁰⁷ For example, a number of industries experienced a great deal of innovation in past eras when discoveries in related fields were thought to be unpatentable. Business methods were not considered patentable subject matter until 1998, yet firms have always sought to operate as efficiently as possible.³⁰⁸ Likewise, the early development of software does not appear to have been impacted by the perennially uncertain status of software as patentable subject matter.³⁰⁹ To the contrary, many attribute the rapid growth of the Internet in part to the open, collaborative culture in which it was developed.³¹⁰

In these industries the efficacy of any patent protection, let alone broad pioneer patent rights, is highly doubtful. When only modest incentives are necessary to spur innovation and sufficiently large incentives are inherent in the market, even modest patent protection

307. See Burk & Lemley, *Policy Levers*, *supra* note 9, at 1617–19 (discussing “competitive innovation” and industries that operate without substantial reliance on the patent system).

308. *Id.* at 1618; see also ROBERT P. MERGES, *PATENT LAW AND POLICY* 155 (2d ed. 1997) (“[T]he relatively frequent innovations in the financial services industry prior to the era of patentability suggest that firms had adequate means to appropriate the value of their new financial innovations.”). *But cf.* John F. Duffy, *Why Business Method Patents?*, 63 *STAN. L. REV.* 1247, 1251–52 (2011) (observing that interest in patenting business methods arose only after the rate of innovation in business and finance began to increase sharply in the latter half of the twentieth century).

309. See Burk & Lemley, *Policy Levers*, *supra* note 9, at 1618–19; see also BOLDRIN & LEVINE, *supra* note 11, at 17–21 (noting the success of open source software); *id.* at 16 (“[I]f people had understood how patents would be granted when most of today’s ideas were invented, and had taken out patents, the industry would be at a complete standstill today.” (quoting Bill Gates, CEO Microsoft Corporation) (internal quotation marks omitted)). In fact, empirical evidence suggests that even today many software firms consider patents to be of limited importance. See Graham et al., *supra* note 218, at 1262 (finding that the majority of start-up companies in the software industry hold no patents at all). Agricultural seeds and plant varieties, which were not patentable until 1970, provide yet another example. See BOLDRIN & LEVINE, *supra* note 11, at 52–57, 80–84.

310. See Burk & Lemley, *Policy Levers*, *supra* note 9, at 1619 (“[T]he open, nonproprietary nature of the Internet is directly responsible for the dramatic innovation it fostered in the 1990s.”). See generally BARBARA VAN SCHEWICK, *INTERNET ARCHITECTURE AND INNOVATION* (2010) (focusing on the open architecture of the Internet). Kal Raustiala and Christopher Sprigman have identified a number of quite innovative industries that seldom rely on intellectual property protection. See Kal Raustiala & Christopher Sprigman, *The Piracy Paradox: Innovation and Intellectual Property in Fashion Design*, 92 *VA. L. REV.* 1687, 1774 (2006) (focusing primarily on the fashion industry, but also noting innovation in football strategy, magic, and fireworks); Kal Raustiala & Christopher Sprigman, *The Creative Cocktail: A Guest Post*, FREAKONOMICS (Dec. 23, 2010, 11:30 AM), <http://freakonomics.blogs.nytimes.com/2010/12/23/the-creative-cocktail-a-guest-post/> (cocktail recipes); Kal Raustiala & Christopher Sprigman, *The Vigilantes of Comedy: A Guest Post*, FREAKONOMICS (Mar. 30, 2010, 2:00 PM), <http://freakonomics.blogs.nytimes.com/2010/03/30/the-vigilantes-of-comedy-a-guest-post/> (stand-up comedy).

will impede innovation. Broad pioneer patent rights will only serve as a greater impediment. This is especially true because the pace of innovation in competitive industries, which have relatively low R&D costs, is particularly rapid.³¹¹ Broad rights, therefore, may allow a pioneer to hold up multiple generations of later-developed technology.³¹²

iii. Discrete

In yet another group of industries, competitors primarily sell simple, stand-alone products that neither incorporate many components nor serve themselves as components of a larger product. Examples include the razor, pen, toy, and packaging industries.³¹³ Inventions in these areas are circumscribed and do not lend themselves to radical improvement.³¹⁴ Thus technology advances via the introduction of wholly new products rather than through the incremental improvement of existing products.

Accordingly, granting especially broad patent scope is unlikely to either hinder or advance innovation. Broad rights will not discourage valuable improvements because there are none to discourage. And broad rights will not incentivize further innovation because inventors are fully protected so long as their patent rights are broad enough to prevent competitors from introducing copycat products.

iv. Biopharmaceuticals

Finally, contrary to recent scholarship calling for the pioneer doctrine's return in the pharmaceutical and biomedical industries, a close examination of these two fields—which, increasingly, are merging into one biopharmaceutical industry³¹⁵—shows that even here broad pioneer rights are unlikely to spur additional innovation.

311. For example, innovation in the computer industry has generally conformed to Moore's Law, which states that computing power will double approximately every two years. See Gordon E. Moore, *Cramming More Components onto Integrated Circuits*, ELECTRONICS, Apr. 19, 1965, at 114, 115.

312. See Cohen & Lemley, *supra* note 193, at 39 (arguing that “[b]ecause software patents have a short effective life” broad claim scope “will give holders of software patents control over many more generations of improvements than patentees in other industries”).

313. See Merges & Nelson, *supra* note 28, at 880–81 (discussing “discrete” industries and identifying examples).

314. *Id.* at 880 (“[I]t is implicit that [discrete] invention does not point the way to wide ranging subsequent technical advances. It does not define any broad prospect.”).

315. See BOLDWIN & LEVINE, *supra* note 11, at 222 (“As of 2004, already more than half of the research projects carried out in the pharmaceutical industry had some biomedical foundation.”).

First, commentators calling for broader patent rights for pharmaceutical and biomedical inventions ignore the fact that patent law already allows inventors in these areas to file extraordinarily broad claims at an early stage of their research. As discussed above, patent law traditionally allows the first inventor of a purified version of a natural substance to claim the purified product itself and not simply the method she used to produce it. This rule has allowed inventors to claim ownership of actual hormones, proteins, genes,³¹⁶ and cells³¹⁷ used for medical diagnostics and treatment—not merely the processes used to produce those substances in a lab. Courts also permit inventors to claim pharmaceuticals even if they do not know or understand why the treatment works and even if they do not know for sure that the treatment will work as disclosed.³¹⁸ Thus, even without the assistance of the pioneer doctrine, patent law ensures that many early pharmaceutical and biomedical inventors will control a broad prospect in need of further development.³¹⁹

Pioneer doctrine proponents also focus on the high cost of pharmaceutical R&D and, in particular, the long delay in commercialization caused by the FDA approval process. But the pace of biomedical research is increasing at a stunning rate. Researchers predict that they will soon be able to decode a human genome—a process that used to take years—in a matter of minutes.³²⁰ In fact, new

316. See *supra* note 150 and accompanying text.

317. See *infra* notes 336–42 and accompanying text.

318. See *supra* notes 199–201 and accompanying text.

319. Contrary to the assumptions of many pioneer doctrine proponents, other commentators have observed that there is little evidence that innovation in the biotech field is hindered by splintered ownership of patent rights. See E. Richard Gold & Julia Carbone, *Myriad Genetics: In the Eye of the Policy Storm*, 12 GENETICS MED. S39, S66 (2010) (“Given that genes have a great variety of applications . . . one would expect higher level of patents blocking research than in other fields. This has not, however, been documented with good empirical data.”).

320. See Boonsri Dickinson, *The Jiffy Lube of Genome Decoding*, DISCOVER MAG., Oct. 2008, at 48, available at <http://discovermagazine.com/2008/oct/20-jiffy-lube-of-genome-decoding> (“It cost nearly \$3 billion and took 13 years to sequence the first human genome Today it would price out at about \$350,000 and take a few months. But Pacific Biosciences in Menlo Park, California, says that as early as 2013 it will have the technology to map all of a person’s DNA in just a few minutes and for mere hundreds of dollars.”); see also Nicholas Wade, *Cost of Decoding a Genome Is Lowered*, N.Y. TIMES, Aug. 11, 2009, at D3 (“[T]he much-discussed goal of the \$1,000 genome could be attained in two or three years. That is the cost, experts have long predicted, at which genome sequencing could start to become a routine part of medical practice.”); Marcus Wohlsen, *Stanford Prof Sequences Own Genome in Weeks*, SEATTLE TIMES (Aug. 11, 2009), http://seattletimes.nwsource.com/html/nationworld/2009634081_apusfastergenescan.html?syndication= (“It might not be long until there is a gene scanner in every doctor’s office, as DNA sequencing becomes faster and cheaper. A Stanford University professor [Stephen

genetic tests are generally available to patients before the patents covering those tests issue. For example, sixty percent of laboratories began conducting tests for hereditary haemochromatosis within fourteen months of publication of the isolated HFE gene.³²¹ Moreover, many promising areas of biomedical research are subject to a truncated FDA approval process or subject to no approval process at all.³²² Also, advances in so-called “personalized medicine” may soon allow pharmaceutical companies to revive already developed drugs that failed to win FDA approval for use by the general public (or were subsequently pulled from the market) to be sold to specific genetic populations for whom they are safe.³²³

Arguments for rejuvenating the pioneer doctrine for pharmaceutical and biomedical inventions also fail to take into account that core advances in these fields are seldom incentivized by the patent system. Many inventions patented in these areas can be directly linked to discoveries made by researchers working in the natural sciences.³²⁴ Frequently, these discoveries open up a number of new technological possibilities and set off a rush among others to patent the many practical applications now “in the air.”³²⁵ Because

R. Quake] reported Monday that he has sequenced his entire genome in a few weeks for under \$50,000 using a single machine.”).

321. Jon F. Merz et al., *Diagnostic Testing Fails the Test: The Pitfalls of Patents Are Illustrated by the Case of Haemochromatosis*, 415 NATURE 577, 578 (2002).

322. See Gold & Carbone, *supra* note 319, at S42 (“[D]iagnostic products and services [can] be put on the market relatively quickly . . . [because they do] not hav[e] to undergo clinical trials in the United States . . .”); Lisa L. Ouellette, Note, *Access to Bio-Knowledge: From Gene Patents to Biomedical Materials*, 2010 STAN. TECH. L. REV., ¶ 57 (2010), available at <http://stlr.stanford.edu/pdf/ouellette-access-to-bio-knowledge.pdf> (“No FDA-approval is needed for genetic tests . . .”). *But cf.* Rita Rubin, *FDA Groups Genetic Tests with Medical Devices, Requiring Approval*, USA TODAY, June 15, 2010, at 7D (explaining that the FDA’s stance on some genetic testing has changed).

323. See Turna Ray, *Big Pharma’s Drug Failure May Be Small Personalized Rx Firm’s Gain, PGx Researcher Says*, GENOMEWEB PHARMACOGENOMICS REP. (Oct. 7, 2009), <http://www.genomeweb.com/dxpgx/big-pharmas-drug-failure-may-be-small-personalized-rx-firms-gain-pgx-researcher->.

324. See ALFONSO GAMBARDILLA, SCIENCE AND INNOVATION: THE US PHARMACEUTICAL INDUSTRY DURING THE 1980S 14 (1995) (“The generation of new drugs depends in large measure on the activities that occur at the outset of the R&D process. Early research stages play a more meaningful role than in other industries, and they are the most creative steps of the drug innovation cycle.”); GOOZNER, *supra* note 144, at 8 (“[T]he inception of drugs which have truly made a difference in recent years . . . can almost always be found in the vast biomedical research enterprise funded by the federal government.”).

325. In a study of all U.S. patent interferences filed between 1980 and 1994, William Kingston found that two patent classes covering pharmaceutical inventions (Nos. 424 and 514) accounted for one-eighth of all interferences. William Kingston, *Light on Simultaneous Invention from U.S. Patent Office “Interference” Records*, 26 WORLD PAT.

advances in pure science are not patentable,³²⁶ these fundamental discoveries could not have been encouraged by the prospect of obtaining patent rights.

Moreover, many biomedical patents are issued to universities hoping to monetize the inventive efforts of their faculty and students.³²⁷ University-affiliated inventors tend to be motivated more by publication, tenure, accolades from their colleagues, and grades or graduation requirements (for students) than by a desire to see their work patented and commercialized.³²⁸ More importantly, the vast majority of biomedical and pharmaceutical research conducted at universities is funded by the U.S. government, with some estimating that private industry picks up less than one-third of the cost.³²⁹ In

INFO. 209, 212–13 (2004). Kingston attributed the predominance of interference in the chemical arts in part to “common sources of basic research information, such as what may be disclosed at specialist Conferences.” *Id.* at 220; *see also id.* at 217 (“The number of chemical patent applications . . . is especially high after important conferences dealing with specific issues. Many firms get ideas from these conferences and eventually file similar patent applications . . .”); Merges & Nelson, *supra* note 28, at 883–84, 904–08 (discussing “science-based industries” and noting that “new scientific and technological developments ‘in the air’ open the possibility of a major advance over prior practice, and the contribution made by the individual or firm who first makes these possibilities operational may be relatively small”). *See generally* THOMAS KUHN, *THE STRUCTURE OF SCIENTIFIC REVOLUTIONS* 35–42 (1962) (conceptualizing scientific progress as a series of “paradigms,” during which much of innovation is merely “puzzle-solving”).

326. *See, e.g.*, *Armour Pharm. Co. v. Richardson-Merrell, Inc.*, 396 F.2d 70, 72 (3d Cir. 1968) (“It has long been a principle of patent law that the discovery of a law of nature cannot form the basis of a patent.”).

327. Brief of Amici Curiae the Regents of the University of California et al. on En Banc Rehearing in Support of Affirmance of Judgment, *supra* note 146, at 22 (“Universities and other research institutions have been pioneers in advancing the biotechnology arts, including recombinant DNA technology, stem cell research, hepatitis B vaccine and many other inventions.”); John M. Golden, *Biotechnology, Technology Policy, and Patentability: Natural Products and Invention in the American System*, 50 EMORY L.J. 101, 109 (2001) (“[T]he multi-billion dollar system of investment, mostly public and mostly university-based . . . provides most of the researchers and basic research that drives modern biotechnology.”).

328. Rebecca S. Eisenberg, *Proprietary Rights and the Norms of Science in Biotechnology Research*, 97 YALE L.J. 177, 182 (1987); Hazuka, *supra* note 270, at 196 (“[A]cademic scientists, who have driven the revolutionary advances in biomedical science, are not generally motivated by the possibility of obtaining patents. Instead, they seek publication and the esteem of their peers. Indeed, much biotechnology upstream, basic research would take place in the absence of the patent system.”); Arti K. Rai, *Regulating Scientific Research: Intellectual Property Rights and the Norms of Science*, 94 NW. U. L. REV. 77, 89–90 (1999) (observing that norms in the scientific research community “promote a public domain of freely available scientific information” and eschew “claiming property rights in invention . . . as immoral”).

329. BOLDWIN & LEVINE, *supra* note 11, at 239–40 (relying on statistics from 1995); *see also* GOOZNER, *supra* note 144, at 8 (“Taxpayer-financed medical research, whether in NIH labs or through government grants to academic and nonprofit medical centers,

1985, the Bayh-Dole Act for the first time authorized universities to patent the results of federally funded university research.³³⁰ Since that time, universities have obtained thousands of patents per year,³³¹ excluding the public from the benefits of research that was incentivized *ex ante* with funds from the public coffers.³³² Further, studies show that universities are ill equipped to license their patent rights, as very few universities profit from their patent licensing programs.³³³

reached \$27 billion in 2003, almost equal to industry spending Over the years, NIH-funded research played not only the key role in virtually all of the basic scientific breakthroughs that underpin modern medicine but also a central role in the application of those findings to the search for many new therapies.”); U.K. INTELLECTUAL PROP. OFFICE, OVERVIEW OF THE UK NATIONAL STEM CELL NETWORK PATENT WATCH LANDSCAPE 13 (Apr. 2010), available at http://www.uknscn.org/downloads/patent_analysis_0811.pdf (studying all stem cell-related patents granted by the IPO between November 2008 and October 2009, and finding that forty percent (38 of 95) were issued to universities); Gold & Carbone, *supra* note 319, at S48 (noting that the National Institutes of Health “has funded part of virtually every major U.S. biomedical research project at some stage”); Anna Schissel et al., *Survey Confirms Fears About Licensing of Genetic Tests*, 402 NATURE 118, 118 (1999) (finding that sixty-seven percent of genetic patents issued in the United States resulted from research funded by the U.S. government); Lisa L. Ouellette, Note, *How Many Patents Does It Take to Make a Drug? Follow-On Pharmaceutical Patents and University Licensing*, 17 MICH. TELECOMM. & TECH. L. REV. 299, 323 (2010) (reporting that patent rights to over nine percent of pharmaceuticals approved by the FDA between 1988 and 2005 are owned in whole or in part by universities or other public institutions).

330. 35 U.S.C. §§ 200–212 (2006).

331. See Rai, *supra* note 328, at 109 (noting that “from 1980 to 1992, the number of patents granted per year to universities increased from fewer than 250 to almost 2,700”); Recent Development, *Columbia, Co-Transformation, Commercialization & Controversy: The Axel Patent Litigation*, 17 HARV. J.L. & TECH. 583, 608 (2004) (reporting that universities were granted more than 3,000 patents in 2000).

332. Notably, there is no evidence that the additional incentive of patent protection increased the quality or quantity of universities’ research output. See BOLDRIN & LEVINE, *supra* note 11, at 228 (“[W]e are not aware of anybody claiming, let alone documenting, that after the Bayh-Dole Act took effect, the quality of biomedical research in U.S. universities and federal sponsored laboratories visibly increased. It just remained roughly where it was, meaning that patentability made no difference as far as general incentives are concerned.”).

333. See Lita Nelsen, *Ten Things Heads of Institutions Should Know About Setting Up a Technology Transfer Office*, in INTELLECTUAL PROPERTY MANAGEMENT IN HEALTH AND AGRICULTURAL INNOVATION 537, 540 (A. Krattiger et al. eds., 2007) (“[B]efore subtracting expenses . . . , technology licensing and spinout equity income averages less than 3% of the amount universities spend on research. And the income distribution is skewed: ten universities in the U.S. (6.3% of the total) account for almost 60% of the total royalty income”); Memorandum from Bob Litan & Lesa Mitchell, Kaufman Found., to Esther Lee, U.S. Dep’t of Commerce 2 (Aug. 17, 2009) (on file with the North Carolina Law Review), available at http://www.autm.net/AM/Template.cfm?Section=Bayh_Dole_Act&Template=/CM/ContentDisplay.cfm&ContentID=4233 (“[T]he majority of university [technology licensing offices] actually lose money—that is, generate less licensing revenue for the university than the cost of their operations.”).

Commentators also fail to appreciate that the unpredictable nature of the biomedical and pharmaceutical arts makes it nearly impossible for a dominant firm to coordinate future innovation. Chemistry and physiology are inherently difficult to predict.³³⁴ Accordingly, it is highly implausible that a pioneer in either field could efficiently orchestrate subsequent innovation. Indeed, technological advances in both industries are largely the work of small firms with a narrow focus.³³⁵ In such an environment, allowing dominant firms broad patent rights would likely result in the destruction of these industries' primary source of innovation.

As in the other industries discussed above, history bears out that firms holding broad patent rights in the pharmaceutical and biotech industries have not been good stewards of their patent prospects. The University of Wisconsin's patent rights covering human embryonic stem ("hES") cell lines provides one such example. In 1998, Dr. James Thomson discovered a process to preserve hES cells in nutrient broth for over a year.³³⁶ Thomson, who conducted his research at the

334. See *In re Fisher*, 427 F.2d 833, 839 (C.C.P.A. 1970) (applying a higher enablement bar to patents covering "chemical reactions and physiological activity" because inventions in these areas generally "involv[e] unpredictable factors"); Golden, *supra* note 327, at 166 ("The unpredictability of biotechnological development makes the coordination of subsequent invention implausible . . ."); see also KENNETH J. BURCHFIEL, *BIOTECHNOLOGY AND THE FEDERAL CIRCUIT* § 6.9, at 118 (1995) (noting the role of uncertainty in obviousness determinations).

335. BOLDRIN & LEVINE, *supra* note 11, at 239 (noting that "useful new drugs seem to come in a growing percentage from small firms, start-ups and university laboratories"); Barnett, *supra* note 274, at 1010 ("Since . . . 1980, biotechnological product development generally has taken place through collaborative networks that . . . match up a small biotechnology firm, which primarily attends to basic research and early product development, and a large pharmaceutical firm, which primarily attends to clinical testing, marketing, and distribution."); Golden, *supra* note 327, at 167 ("[T]he American biotechnology industry . . . operates according to a 'mayfly' or 'small company' model that explicitly seeks to unleash hundreds of small, lean (with regard to capital resources), and largely similar firms to engage, for the duration of their frequently short lives, in a voracious search for ways of converting bioscience into marketable technology."); Yusing Ko, *An Economic Analysis of Biotechnology Patent Protection*, 102 *YALE L.J.* 777, 800 (1992) ("[T]raditional pharmaceutical companies, despite their superior innovative resources, lag far behind the small start-up companies in contributing to biotechnological innovations."); Mazzoleni & Nelson, *supra* note 271, at 276 (noting that if large pioneer firms had been awarded broader patent rights "[t]he collection of small and medium sized firms in the American biotechnology industry . . . would not have come into existence").

A recent example of this phenomenon is the pharmaceutical establishment's reluctance to embrace and develop the field of pharmacogenomics—i.e., "personalized medicine" or "PGx," the use of a patient's unique genetic makeup to optimize drug therapy—leaving that task to smaller, leaner firms. See T. Bartfai, *Pharmacogenomics in Drug Development*, 4 *PHARMACOGENOMICS J.* 226, 227–28 (2004); Ray, *supra* note 323.

336. See generally James A. Thomson et al., *Embryonic Stem Cell Lines Derived from Human Blastocysts*, 282 *SCIENCE* 1145 (1998) (describing the hES preservation process).

University of Wisconsin-Madison, a public university,³³⁷ credited his achievement in part to exogenous advances in cell-growth technology.³³⁸ Nonetheless, on the basis of Thomson's discovery, the university was able to obtain patent rights covering embryonic stem cells themselves—claims so broad they effectively covered *all* hES cell lines produced thereafter in the United States, regardless of how they were produced.³³⁹

Much in the same fashion that Selden used his patent rights in the early days of the automobile, the University of Wisconsin has used its patent rights to extract large royalties from commercial hES cell researchers.³⁴⁰ Wisconsin's aggressive attempts to enforce its

337. Though Thomson's research was supported by the University of Wisconsin, *see id.* at 1147, it did not receive federal funding, *see* Rick Weiss, *A Crucial Human Cell Isolated, Multiplied: Embryonic Building Block's Therapeutic Potential Stirs Debate*, WASH. POST, Nov. 6, 1998, at A14.

338. Weiss, *supra* note 337 ("He credited his success in part to the recent availability of new nutrient broths that have made it easier to grow human embryos up to about the five-day mark, when embryonic stem cells can be taken from the embryo's so-called inner cell mass.").

339. *See* U.S. Patent No. 5,843,780 (filed Jan. 18, 1996); U.S. Patent No. 6,200,806 (filed June 26, 1998); U.S. Patent No. 7,029,913 (filed Oct. 18, 2001); Hazuka, *supra* note 270, at 174 (noting that the Wisconsin Alumni Research Foundation ("WARF") "has interpreted these claims to apply 'to any cell that is derived from a human embryo and continues to thrive and multiply without specializing.'" (quoting N. Zeke Campfield, *U. Wisconsin: Stem-Cell Research Places U. Wisconsin in National Spotlight*, BADGER HERALD (Aug. 31, 2001), http://badgerherald.com/news/2001/08/30/stem-cell_research_p.php)). These patents are held by WARF, the university's patent-licensing arm. WARF has exclusively licensed its patent rights for a number of applications to Geron Corporation, which contributed funding to Thomson's research. *See* Kathleen Gallagher, *Geron to Begin Clinical Trials for Stem Cell Therapy*, MILWAUKEE-WIS. J. SENTINEL (Jan. 23, 2009), <http://www.jsonline.com/business/38222494.html>. The PTO granted two public interest groups' request to reexamine WARF's patents in 2006. *See* Constance Holden, *WARF Goes 3 for 3 on Patents*, SCIENCE NOW (Mar. 12, 2008, 12:00 A.M.), <http://news.sciencemag.org/sciencenow/2008/03/12-04.html?rss=1>. All three patents survived reexamination (with narrowing amendments) in 2008, *id.*, though the Board of Patent Appeals and Interferences reversed the confirmation of patentability of one patent in 2010, *see Ex parte* Wis. Alumni Research Found., No. 2010-001854, 2010 WL 1734377 (B.P.A.I. 2010).

Initially, WARF's patent monopoly was strengthened even further by President George W. Bush's decision to limit federal funding to research using cell lines in existence prior to August 9, 2001. *See* Katharine Q. Seelye, *Bush Gives His Backing for Limited Research on Existing Stem Cells: No New Embryo Use*, N.Y. TIMES, Aug. 10, 2001, at A1. The Obama Administration reversed this decision in early 2009. *See* David Stout & Gardiner Harris, *Obama Reversing Stem Cell Limits Imposed by Bush*, N.Y. TIMES, Mar. 7, 2009, at A1.

340. *See* Gallagher, *supra* note 339 ("WARF has 30 commercial embryonic stem cell licensees, and many more in discussion . . ." (internal quotation marks omitted)); Terri Somers, *Foundation's Stem Cell Patents Impede Research, Scientists Say*, SAN DIEGO UNION-TRIB., July 30, 2006, at A1, available at <http://www.signonsandiego.com/uniontrib>

patent rights in the United States—including its insistence that license agreements include “reach-through” provisions guaranteeing the university a royalty on any products licensees develop using stem cells³⁴¹—has impeded hES cell research in the United States and led many researchers to leave the country entirely.³⁴²

The ongoing battle over Myriad Genetics’ ownership of gene sequences associated with increased risk of breast cancer provides yet another example. In the late 1980s and early 1990s, as many as seven research teams located in the United States and abroad raced to be the first to identify and sequence genes associated with hereditary breast cancer.³⁴³ One such team was led by Mark Skolnick at the University of Utah’s Center for Genetic Epidemiology. Skolnick’s team was supported by a mix of federal funding and private investment in Myriad, a university spin-off created to finance the team’s research.³⁴⁴ In 1994 and 1995, respectively, the Myriad team successfully isolated two gene sequences (BRCA1 and BRCA2) carried by women with an increased risk of developing breast and

/20060730/news_1n30stems.html (“Under the patents, a researcher in the United States who uses embryonic stem cells in any way must pay a licensing fee to WARF, the university’s licensing arm.”); *see also id.* (“[C]ommercial biotechnology and pharmaceutical companies must pay . . . licensing fees . . . as high as \$250,000 . . . [a]nd . . . annual maintenance fees of about \$40,000.”). WARF also requires licenses for academic researchers, but charges substantially less. *See* Kathleen Gallagher, *Group Wins Patent Fight*, MILWAUKEE-WIS. J. SENTINEL, Mar. 12, 2008, at D1, available at <http://www.jsonline.com/business/29467229.html> (“WARF has 914 academic [stem cell] licensees . . .”); Somers, *supra* (“Originally, WARF charged research institutes \$5,000, but that fee recently was reduced to \$500.”).

341. *See* Constance Holden, *U.S. Patent Office Casts Doubt on Wisconsin Stem Cell Patents*, 316 SCIENCE 182, 182 (2007); Somers, *supra* note 340 (describing WARF’s “reach-through royalty clause, where they say anything you’ve invented remotely by using human embryonic stem cells will now have a royalty obligation back to WARF” (quoting Joydeep Goswami, Invitrogen Vice President for Stem Cells and Regenerative Medicine) (internal quotation marks omitted)).

342. *See* Sandy Kleffman, *Stem Cell Research’s Newest Foe: Patents*, CONTRA COSTA TIMES (Walnut Creek, Cal.), at F4 (“[WARF’s] patents are impeding our research . . . It is making scientists go overseas to do this sort of research . . . It isn’t the funding that’s sending us overseas. It’s the patent issues.” (quoting Jeanne Loring, Director, Stem Cell Research, Burnham Institute for Medical Research) (internal quotation marks omitted)); Somers, *supra* note 340 (“In Singapore, Israel, the United Kingdom, Sweden and China, experts are plowing ahead with this promising science, unfettered by the patents and supported by government research funding not available in this country. As a result, many U.S.-based scientists are looking for opportunities to take their work abroad.”); Terri Somers, *Stem Cell Patent Ruling Contested*, SAN DIEGO UNION-TRIB., July 19, 2008, at C3, available at http://www.signonsandiego.com/uniontrib/20080719/news_1b19stems.html (“No other country in the world recognizes the WARF stem cell patent.”).

343. Gold & Carbone, *supra* note 319, at S40.

344. Skolnick’s University of Utah team received \$5 million from the National Institutes of Health and raised \$10 million from sales of Myriad stock. *Id.* at S41, S64.

ovarian cancer, narrowly beating out competing researchers.³⁴⁵ On the basis of these discoveries, Myriad won patent rights (shared with the University of Utah) covering the two gene sequences themselves, as well as associated mutations and diagnostic tests—claims so broad that they effectively gave Myriad the right to control all genetic testing for breast and ovarian cancer.³⁴⁶

Much like General Electric a century before, Myriad aggressively asserted its patent rights to exclude competitors from the genetic diagnostics market, many of whom hoped to market superior tests. By the time Myriad began to market its own test for the BRCA genes, many laboratories were already performing genetic tests for hereditary breast cancer using alternative methods.³⁴⁷ Myriad quickly sought to eliminate its competition by threatening suit for patent infringement. In the United States, Myriad sent cease-and-desist letters to the Genetics and IVF Institute and to the University of Pennsylvania's Genetics Diagnostic Laboratory, both of which soon acquiesced to Myriad's demands.³⁴⁸ Myriad also threatened suit and trade sanctions abroad in protracted disputes with the national health care systems of Canada, France, the United Kingdom, and Australia.³⁴⁹

While Myriad was focused on excluding competitors, independent researchers continued to discover new mutations of the BRCA genes—mutations that were not included in Myriad's tests for years and which Myriad's patent rights prohibited others from

345. *Id.* at S41. Another company associated with the University of California at Berkeley, OncorMed, actually obtained patent rights to one BRCA1 allele before Myriad's patent covering 47 BRCA1 mutations issued a few months later. *Id.* Myriad subsequently purchased OncorMed's patents. *Id.* In December 1995, Myriad announced that it had isolated and sequenced BRCA2 and filed a related patent application just one day before a research team from the United Kingdom published an article containing the gene's sequence. *Id.*

346. Robert Cook-Deegan et al., *Impact of Gene Patents and Licensing Practices on Access to Genetic Testing for Inherited Susceptibility to Cancer: Comparing Breast and Ovarian Cancers with Colon Cancers*, 12 GENETICS MED. S15, S15 (2010) (noting that "Myriad is the sole provider of full-sequence BRCA testing in the United States"); Gold & Carbone, *supra* note 319, at S64 ("On paper . . . Myriad could effectively block anyone, including governments and other researchers . . . from providing genetic tests for breast and ovarian cancer . . ."). On the basis of its U.S. patent applications, Myriad was also able to obtain patent rights in Canada, Europe, Australia, New Zealand, and Japan. Gold & Carbone, *supra* note 319, at S43.

347. Gold & Carbone, *supra* note 319, at S64 ("[M]any clinical laboratories had already developed genetic tests without a patent and others were poised to do so.").

348. *Id.* at S42.

349. *Id.* at S43, S51–52 (discussing Myriad's threats of suit and trade sanctions to four Canadian provinces); *id.* at S54–57 (discussing Myriad's efforts to enforce its patent rights in Europe, Australia, and New Zealand).

marketing in new comprehensive tests.³⁵⁰ In some instances, concern in the research community about the broad scope of Myriad's patent rights deterred many researchers from sharing newly discovered mutations with the public or even searching for new mutations in the first place.³⁵¹ Worse still, those same fears led many labs to discontinue testing for the BRCA gene altogether, thereby denying many patients the benefit of even inferior testing.³⁵²

v. Chilling Innovation Across Industries

Though the analysis above does not address each and every industry, the harm done by broad pioneer patents in the early markets for steam power, electrical lighting, and, most recently, biopharmaceuticals strongly suggests that the pioneer doctrine's costs exceed its benefits regardless of market characteristics. Indeed,

350. Cook-Deegan et al., *supra* note 346, at S16 (noting that as of 2006 "Myriad's testing strategy . . . missed up to 12% of large genomic deletions or duplications"); Gold & Carbone, *supra* note 319, at S44-45 (discussing research establishing that many women had BRCA mutations despite receiving negative test results from Myriad); *id.* at S55 (discussing the French Institute Curie's objections to Myriad's test, including that "its own genetic diagnostic test . . . was better than that provided by Myriad, especially because it identified large-scale rearrangements which . . . Myriad's test did not find").

351. Gold & Carbone, *supra* note 319, at S61 ("[R]esearchers, clinical laboratory directors, commentators, and policymakers . . . uniformly agreed that Myriad would actively pursue any researcher who worked on the BRCA1/BRCA2 genes. . . . Instead of more research being done on the two genes, some researchers either stopped working on them or at least stopped contributing their results to public databases.").

352. Mildred K. Cho et al., *Effects of Patents and Licenses on the Provision of Clinical Genetic Testing Services*, 5 J. MOLECULAR DIAGNOSTICS 3, 6 (2003) (finding that 9 of 122 surveyed U.S. laboratories stopped conducting genetic tests for the BRCA genes due to fear of infringement litigation with Myriad); *see also* Gold & Carbone, *supra* note 319, at S44 (collecting other studies). Myriad is not the only entity accused of suppressing improved genetic tests. *See* SEC'Y'S ADVISORY COMM. ON GENETICS, HEALTH, & SOC'Y, U.S. DEP'T OF HEALTH & HUMAN SERVS., REPORT ON GENE PATENTS AND LICENSING PRACTICES AND THEIR IMPACT ON PATIENT ACCESS TO GENETIC TESTS 3 (2010), available at http://oba.od.nih.gov/oba/sacghs/reports/SACGHS_patents_report_2010.pdf; Cho et al., *supra*, at 8 (identifying patents covering eleven other genetic tests); Merz et al., *supra* note 321, at 578 (finding that twenty-six labs were not performing tests for the patented HFE gene linked to hereditary haemochromatosis). *But see* Subhashini Chandrasekharan et al., *Impact of Gene Patents and Licensing Practices on Access to Genetic Testing for Cystic Fibrosis*, 12 GENETICS MED. S194, S194 (2010) (finding "no evidence that patents have significantly hindered access to genetic tests for [cystic fibrosis] or prevented financially cost-effective screening").

The Federal Circuit recently upheld the validity of Myriad's patent claims covering the isolated BRCA genes themselves, reversing a prior ruling by the Southern District of New York that isolated human DNA was not patentable subject matter. *See* Ass'n for Molecular Pathology v. U.S. Patent & Trademark Office, No. 2010-1406, 2011 WL 3211513, at *1 (Fed. Cir. July 29, 2011) (affirming, however, the invalidity of Myriad's method claims directed merely to the comparison of gene sequences with the patented BRCA genes).

lessons learned from these case studies are by no means as industry specific as they may appear. The biopharmaceutical industry's experience with dominant university-backed ventures like Myriad, for example, is readily translatable to markets for bulk chemicals, synthetic materials, and semiconductors, all of which rely heavily on unpatentable scientific advances made in inherently unpredictable fields.³⁵³ Thus it is with a healthy dose of skepticism that we should view industry-specific calls for generous pioneer protection. History, after all, shows that dominant pioneers have time after time used their patent rights to jealously guard market share and monopoly profits, rather than foster next-generation technology as prospect theory predicts.

CONCLUSION

The pioneer invention doctrine is of a bygone era. Instituted more than two hundred years ago in a patent system that virtually no inventor or patent attorney would recognize today, the pioneer doctrine is an anachronism in twenty-first century patent law. Before the advent of patent claims, inventors and courts alike required a mechanism to determine the outer bounds of patent rights. The pioneer doctrine fulfilled this need and commendably ensured that patent rights bore some relation to the importance and novelty of patented inventions. Now, patent claims play this role and have done so for more than a century. Early inventors working in new fields are rewarded with broad claims. Later improvers receive, at best, long and convoluted claims hemmed in by prior art.

Though courts and commentators have long argued otherwise, there is no sound reason to believe that the inherent dominance of pioneer claims is jeopardized by claim-drafting frictions or disparate treatment at the patent office. Today more so than ever, patent prosecution pits sophisticated lawyering against an overwhelmed and understaffed PTO. Thanks to doctrinal advantages like favorable standards for enablement and reduction to practice, patent law ensures that applicants disclosing inventions in nascent fields will be richly rewarded. Combined with the fact that patentees continue to benefit from reissue and continuation applications, the doctrine of equivalents, and hindsight bias for years after their patents issue, there is simply no reason to believe that certain patentees' rights deserve further expansion.

353. See Kingston, *supra* note 325, at 217, 220; Merges & Nelson, *supra* note 28, at 897-908.

To the contrary, the history of innovation strongly suggests that “pioneer” inventions and “heroic” inventors are nothing more than modern-day technological mythology.³⁵⁴ A close reading of history dispels the notion that rare strokes of genius drive innovation. Unromantic as it may seem, virtually every celebrated invention was independently made by multiple competitors racing to claim credit for what was widely regarded as an inevitable result. The surprising prevalence of multiple invention belies repeated claims by supporters of the pioneer doctrine that a trove of important discoveries lies in wait just beyond the innovation-inducing powers of the patent system.

History further suggests that extending broad patent rights to early inventors in new fields will generally chill, if not entirely freeze, innovation for years at a time. As the case studies presented above attest, dominant pioneers have time and again, in industry after industry, suppressed superior products developed by the next generation of innovators. From Watt’s domination of steam engine technology at the dawn of the industrial revolution to the University of Wisconsin’s ongoing control over stem cell research today, all evidence suggests that broad pioneer patent rights fail to encourage innovation *ex ante* and, in fact, actually harm innovation *ex post*.

Nonetheless, all would be well and good if, as conventional wisdom suggests, the pioneer doctrine were dead letter. Unfortunately, like popular narratives celebrating heroic inventors, conventional wisdom with respect to the pioneer doctrine omits much from the story. While it is true that the pioneer doctrine rarely appears in published opinions of the Federal Circuit, the doctrine is far from dead. Patentees frequently raise it, at least as often as several much-discussed doctrines; courts routinely apply it, especially at the district court level; and scholars regularly call for its rejuvenation in misguided attempts to cure any of a host of problems, from economic stagnation to splintered ownership of the human genome.

Luckily, the solution is straightforward. Rather than allow the pioneer doctrine to persist in a state of legal limbo, Congress, the Supreme Court, or the Federal Circuit should once and for all do away with the doctrine and make clear that no invention, no matter how purportedly groundbreaking, is eligible for special treatment

354. LAMB & EASTON, *supra* note 2, at 202 (“Whilst revolutionaries may avail themselves of scientific discoveries, scientific discoverers are rarely revolutionary. The picture of a bold scientist venturing into the unknown is a Victorian myth.”); HERBERT ALEXANDER SIMON, *MODELS OF DISCOVERY* 266 (1977) (“The subject of scientific discovery . . . has always been surrounded by dense mists of romanticism and downright know-nothingism.”).

under the patent laws.³⁵⁵ Such a reform, which merely nudges reality in line with conventional wisdom, could hardly draw much opposition or controversy.

This is not to say that every argument made in favor of the pioneer doctrine is without merit. To be sure, claim drafting is a difficult practice prone to inadvertent error, and in many industries fractionalized ownership of patent rights is a significant hurdle to innovation.³⁵⁶ Fortunately, there are numerous alternative solutions to these problems that do not carry with them a significant risk that patentees will achieve monopolistic power over an industry. To improve claim-drafting frictions, a better course of action is simply to encourage patentees to take full advantage of the tools available to them at the time of prosecution and shortly thereafter: in particular, their ability to file multiple claims using words of approximation and to avail themselves of the neglected reissue mechanism. Similarly, to reduce the thicket of narrow patent rights clogging certain industries, one simple and elegant solution is to raise the bar for obviousness. Such a reform would give early patentees adequate room to breathe without compromising later competitors' incentives to invest in the development of legitimate improvements of their own.³⁵⁷

The long history of the pioneer doctrine is a cautionary tale that implicates the function of appellate courts, the scope of legal scholarship, and the very principles upon which technology policy is set. Judicial proclamations abruptly altering long-standing doctrine must ring with finality, lest antiquated doctrines endure with unintended consequences. Legal scholarship must also strive to

355. This is very likely what the Federal Circuit panel believed it was doing in *Texas Instruments, Inc. v. U.S. International Trade Commission*, 805 F.2d 1558 (Fed. Cir. 1986). Unfortunately, the panel chose to take the easy course and diminish the doctrine's importance rather than highlight it for further consideration en banc or by the Supreme Court.

356. Recent scholarship by Christopher Holman, however, casts at least some doubt on concerns about the purported density of the patent thicket plaguing the biotech industry. See Christopher M. Holman, *Will Gene Patents Impede Whole Genome Sequencing?: Deconstructing the Myth that Twenty Percent of the Human Genome is Patented* 1–2 (Univ. of Mo., Kan. City Sch. of Law, Working Paper, 2011), available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1894715 (explaining why the oft-cited statistic that twenty percent of the human genome is patented is merely an “urban legend”).

357. See generally Vermont, *supra* note 93 (arguing that pioneer patents should receive broader claim scope for purposes of applying the obviousness requirement to competitors' improvement patents, rather than broader claim scope for purposes of determining infringement against competitors' products). In fact, as discussed *supra* notes 30–32 and accompanying text, the pioneer doctrine was originally created for this purpose in case law invalidating narrow improvement patents as anticipated by earlier pioneers. See *Evans v. Eaton*, 20 U.S. (7 Wheat.) 356, 430–35 (1822).

evaluate more than the latest doctrinal trends. Patent law is, after all, far more than what happens at the Supreme Court or the Federal Circuit. Finally, and most importantly, patent policy must not be dictated by rote reliance on popular notions of invention that have little basis in reality, among them: that patent rights are always necessary to encourage exploration of promising but uncertain innovations, that the most valuable technological contributions of all are those that break new ground rather than significant improvements that come later, and that innovation primarily proceeds through rare leaps made possible by singular strokes of genius. A patent system designed with heroic inventors and pioneering inventions in mind will, unfortunately, guide investment in innovation with the same accuracy as the historical foundation upon which it rests.

