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Interring the Pioneer Invention Doctrine

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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. As a society, we lionize and mythologize these individuals as the singular geniuses who made our modern lives possible.

It should come as no surprise then that U.S. patent law traditionally favors extraordinary technological advances: "pioneer
inventions" in patent parlance.\textsuperscript{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.\textsuperscript{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,\textsuperscript{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.\textsuperscript{6}

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

\begin{itemize}
\item \textsuperscript{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).

\item \textsuperscript{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").

\item \textsuperscript{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.

\item \textsuperscript{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.
\end{itemize}
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. 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. 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. Whether and how patent law adapts to this rising

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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 RIPKIN, THE BIOTECH CENTURY: HARNESSING THE GENE AND REMAKING THE WORLD 1–4 (1998); Hank Greely, Law and the Biosciences, STAN. L. REV., 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

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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, useful, and non-obvious. She must also describe her invention with specificity sufficient to enable others with knowledge of the relevant art to make and use the invention.

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. A patent applicant is free to draft her claims as broadly as she believes


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(e), 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. Claims that merely cover obvious modifications to the prior art are likewise invalid. And, claims drafted so broadly that they cover novel technology beyond what the applicant described in her specification are invalid for “lack of enablement.”

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. An applicant may then narrow her rejected claims and resubmit them for subsequent rounds of consideration. This back-and-forth process may run through multiple iterations before the examiner deems any claims patentable.

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

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17. See, e.g., Verdegaal 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) (“To 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.’ ”).


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.


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. Because patentees and alleged infringers rarely agree about the literal scope of patent claims, courts typically reserve judgment about literal infringement until after issuing a Markman ruling defining disputed claim terms or phrases.

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.”


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.

Courts enjoy considerable discretion in determining what range
of equivalents fall within a patentee’s rights 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. 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. Though
many pioneer inventions have been recognized over the years,
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.”

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. Instead, inventors were
only required to provide a “specification ... to distinguish the

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.”).
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.
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

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).
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, while patents disclosing “an improvement . . . not founded on any new discovery” received narrow protection.

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. By that time, courts and patentees generally regarded patent claims as establishing the periphery, rather than the core, of patent rights, and infringement analysis began to focus on the literal scope of claim language. 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. 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.”).


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.”).

machine may contain improvements in the separate mechanisms which go to make up the machine.\textsuperscript{46}

As this quote suggests, the nascent doctrine of equivalents was available only to pioneer inventions.\textsuperscript{47} If the patentee was not "a pioneer in the art," he was not "allowed to invoke the doctrine of equivalents."\textsuperscript{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 \textit{Continental Paper Bag Co. v. Eastern Paper Bag Co.},\textsuperscript{49} the Supreme Court held for the first time that a non-pioneer patent could benefit from the doctrine of equivalents.\textsuperscript{50} In that case, the Court applied the doctrine to a patent that, though not a pioneer, was nonetheless a patent "of high rank."\textsuperscript{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.\textsuperscript{52}

By 1950, rules favoring pioneer patents had completely transitioned from the doctrine of equivalents to merely part of the doctrine of equivalents. In \textit{Graver Tank & Manufacturing Co. v. Linde Air Products},\textsuperscript{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.\textsuperscript{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

\textsuperscript{48} Id.
\textsuperscript{49} 210 U.S. 405 (1908).
\textsuperscript{50} Id. at 415.
\textsuperscript{51} Id. at 414.
\textsuperscript{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").
\textsuperscript{53} 339 U.S. 605 (1950).
\textsuperscript{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).
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 ... becau[s] even more complete after [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*, 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.” Writing for the panel, Judge Newman reiterated the court’s holding two years prior that Texas Instruments’ handheld calculator patent was a “pioneer,” 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.

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.” 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.* without mentioning the pioneer doctrine once.

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

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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).
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

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.
73. See Burk & Lemley, Biotechnology, supra note 9, at 738 (calling for the pioneer doctrine to be “rejuvenated”); 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*, the Supreme Court reversed that decision in an opinion that specifically mentioned on-going "judicial recognition of so-called 'pioneer' patents." 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*.

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.*

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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).


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.michigancasebook.org/assets/firstimpressions/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 "limited ... 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

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78. *Id.* at 1371; see also *Molten Metal Equip. Innovations, Inc. v. Metaullcys Sys. Co.*, 56 F. App'x 475, 480 (Fed. Cir. 2003) (non-precedential opinion per FED. CIR. R. 3.21) (approving a jury instruction stating that "a pioneering invention . . . is [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. 3.21) (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 "demark[] 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. 3.21) (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).

equivalents,\textsuperscript{82} the scope of patentable subject matter,\textsuperscript{83} and the entire market value rule.\textsuperscript{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.\textsuperscript{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 naot 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.").


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).

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


\textsuperscript{89} Allison & Lemley, supra note 27, at 963, 966, 978 (finding that prior to the Supreme Court’s opinion in \textit{Markman} v. \textit{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); \textit{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, \textit{Abolishing the Doctrine of Equivalents and Claiming the Future After Festo}, 19 \textbf{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, and this growth has been especially concentrated in a number of fields, namely computing and complex electronics. 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.”

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. 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. Such attempts have not always been unsuccessful. For example, a small, but significant line of precedent holds that pioneer

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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”).


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. Another lowers the bar pioneers must hurdle to obtain an injunction. 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. 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."

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").


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. 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. If, as many predict, biotechnology replaces computer technology as the most visible and lucrative area of innovative growth in the twenty-first century, 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. 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

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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”).

106. See Burk & Lemley, Biotechnology, supra note 9, at 738 (suggesting that “rejuvenating the doctrine of pioneer patents” would help “minimize the anticommons 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-emphasizing 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. 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. 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. 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.

(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.


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. As one court put it, the “conversion of machine to words allows for unintended idea gaps which cannot be satisfactorily filled.” 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. 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.

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. 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 “date[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.\textsuperscript{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.\textsuperscript{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 relationship\textsuperscript{118}—patent prosecutors simply fail to comprehend, and thus to claim, the full extent of the invention.\textsuperscript{119}

\textsuperscript{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, unreected elements or method steps. . . . The transitional phrase ‘consisting of’ excludes any element, step, or ingredient not specified in the claim.").

\textsuperscript{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. L.J., 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”).

\textsuperscript{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)).

\textsuperscript{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."); Saroff, supra note 89, at 1208 ("The modern doctrine of equivalents thus operates principally as an insurance policy against potential but unrecognized mistakes in drafting . . . .").
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. Again, this friction is thought to be particularly pernicious for pioneer inventors drafting claims covering a nascent, quickly evolving technology. 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. 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.

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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. 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.

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. 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. 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

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.  

Without additional incentive from the patent system, commentators fear, such inventions will be long-delayed or never developed at all.  

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.

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

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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. 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. Thus, common pastures will be overgrazed, common waters overfished, common woodlands deforested, and the like. 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. 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. 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.

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.
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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{144} Further, absent strong patent

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\item\textsuperscript{140} Kitch, supra note 105, at 267–75.
\item\textsuperscript{141} Id. at 276.
\item\textsuperscript{142} Id. at 279.
\item\textsuperscript{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.").
\item\textsuperscript{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).
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 protección, imitación en la industria farmacéutica es relativamente fácil. Si los derechos de un inventor se limitan a la composición que desea vender, los competidores pueden desarrollar una alternativa genérica usando un análogo químico cercano y, en ciertas circunstancias, pueden evitar el proceso de aprobación del FDA por completo.\textsuperscript{145} Por lo tanto, en el frente de la concesión de altas rivalidades, las empresas farmacéuticas pueden optar por no hacer los grandes inversiones necesarios para desarrollar un nuevo fármaco.\textsuperscript{146}

3. Aclarando Patentes, Especialmente en la Industria de la Biotecnología

Finalmente, en un corolario más moderno a la teoría de Kitch, varios académicos han argumentado que extender derechos de patente más amplios a pioneros podría aumentar la innovación en industrias en donde “patentes de anticommons” hacen que el desarrollo de nuevas tecnologías sea más costoso.\textsuperscript{147} Una patente de raíces arañizadas se produce cuando varias patentes con escaso margen de cobertura cubren el mismo producto.\textsuperscript{148} Similarmente, un anticommons existe donde los inputs o los pasos en la fabricación de un producto final fueron individualmente patenteados por varios inventores.\textsuperscript{149} En ambos casos, el carácter fragmentado de los derechos de patente obstaculiza la innovación porque una empresa que desea vender un producto debe

\textsuperscript{145} Por presentación de una solicitud de Aprobación de Nueva Sustancia Abreviada, un fabricante de fármacos genéricos puede solicitar la aprobación del FDA antes de que los patentes de los fabricantes de productos de marca-name expire. \textit{Se Federal Foreign, 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).}

\textsuperscript{146} \textit{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 . . . .”).}

\textsuperscript{147} \textit{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.”).}


\textsuperscript{149} \textit{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. 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.

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. 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. Free from the constraints of closely related prior art, pioneer inventors can draft claims using broad language.

There is simply no evidence that pioneer inventors draft unduly narrow claims. 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. 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.”

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.


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. 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. The Markush claiming format similarly allows an
inventor to claim an invention with an element selected from a known
class of substitutes.

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. Courts also routinely uphold patent claims that
contain terms of degree like “approximate,” “substantially,” and
“readily.” 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."  

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. 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. 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." The reissue mechanism, which has been available to patentees since at least the early 1830s, was actually designed to facilitate the correction of claim-drafting mistakes.
Further, courts occasionally apply the doctrine of equivalents to stretch even the most precise claim language. In *Winans v. Denmead*, 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. Similarly, in *Warner-Jenkinson Co. v. Hilton Davis Chemical Co.*, the Court held that a rather exacting claim for a dye purification process requiring a \( \text{pH} \) 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 \( \text{pH} \) of 5.0.

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.

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

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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.

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.\textsuperscript{174} Because the meaning of claim terms will inevitably be determined by a judge many years after the patent issued,\textsuperscript{175} patentees benefit from this subtle evolution.\textsuperscript{176} In \textit{SuperGuide Corp. v. DirecTV Enterprises},\textsuperscript{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.\textsuperscript{178} Likewise, in \textit{Laser Alignment, Inc. v. Woodruff & Sons},\textsuperscript{179} the Seventh Circuit held that the 1957 claim term “collimated beam of light” literally covered laser technology.\textsuperscript{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 \textit{B.G. Corp. v. Walter Kidde & Co.},\textsuperscript{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.”\textsuperscript{182}

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\textsuperscript{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, \textit{The Changing Meaning of Patent Claim Terms}, 104 Mich. L. Rev. 101, 102 (2005).

\textsuperscript{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, \textit{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).

\textsuperscript{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.

\textsuperscript{177} 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).

\textsuperscript{178} 358 F.3d 870 (Fed. Cir. 2004).

\textsuperscript{179} 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).

\textsuperscript{180} 491 F.2d 866 (7th Cir. 1974).

\textsuperscript{181} Id. at 872.

\textsuperscript{182} 79 F.2d 20 (2d Cir. 1935).
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., for example, Judge Learned Hand upheld a patent covering purified human adrenaline, not just the process for purifying the natural substance. 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., 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.

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. The Supreme Court has expressly held that “the question under the doctrine of equivalents is whether an accused element is equivalent to a claimed

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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).
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).
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."

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,* 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.

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.' "

Finally, because equivalency is determined as a legal matter "at the time of infringement," and as a practical matter during the course of litigation occurring well after infringement began, patentees benefit greatly from hindsight bias. 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

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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.
significant at the time it was made." 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. 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." 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. Similarly, an inventor can quickly claim a compound made from a particular process before the inventor is capable of identifying the compound.

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

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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. Courts have also held that a patentee need not know or understand why his invention works. Indeed, a patentee need not even know for sure whether his invention is useful for the purpose disclosed in the specification.

b. Continuation Applications

In any event, patentees who need additional time to draft claims are protected by the availability of continuation applications. At any time during the life of her patent, a patentee can file a continuation application in hopes of winning broader claims. 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. 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.

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

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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," 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. 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.

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. 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. 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.

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.").
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 subliteratures.").
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.\textsuperscript{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,\textsuperscript{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.\textsuperscript{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.\textsuperscript{215} Because a firm challenging a patent bears the full cost of

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\item 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”).
\item \textsuperscript{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, \textit{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, \textit{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).
\item \textsuperscript{213} On average, a patent examiner will spend just eighteen hours total on each application he reviews. See Mark A. Lemley, \textit{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. \textit{Patent Inventory Statistics—FY09}, U.S. PATENT & TRADEMARK OFFICE, http://www.uspto.gov/patents/stats/appbacklog.jsp (last modified Oct. 7, 2009).
\item \textsuperscript{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.
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. 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.

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. 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. 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. 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.

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 minuscule 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.” 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).
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. 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, a commercial trust reviled in its time for charging "ruinous" prices and employing a "number of lobbyists' to obtain improper extensions of [its] patents. By the time his patent expired in 1867, Howe had amassed more than two million in royalties without ever manufacturing a single sewing machine.

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. 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," 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 Steinhiel.

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. 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.


228. Id. at 107.

229. Id. at 110–11.

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.

competitors at virtually the same time. The list of well-documented examples is long and includes the microscope, the telescope, the thermometer, the sextant, the light bulb, photography, television, the typewriter, the triode, the invention in the medical arts); Mark (discussing the surprisingly cumulative nature of fifteen "pioneering inventions").


237. Ogburn & Thomas, supra note 236, at 96 (listing Johannides, Drebbe, 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).


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

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

\textsuperscript{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).

\textsuperscript{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.

\textsuperscript{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).

\textsuperscript{250} See, e.g., Merjes, 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.”).

\textsuperscript{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).

\textsuperscript{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).

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


\textsuperscript{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.”).

\textsuperscript{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.”).

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

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

\textsuperscript{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 breakthroughs\(^2\) 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,\(^2\) 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.”\(^2\) Therefore, it could be argued, the appropriate reward

\(^{260}\) **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, Jirgen 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.


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?”).
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. 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. Far more likely to spur groundbreaking innovation are the many natural advantages, discussed above, that pioneers have over their late-comer competitors.

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

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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).


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.\textsuperscript{267} Before that time, Japanese patents were strictly limited to one claim.\textsuperscript{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.\textsuperscript{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.\textsuperscript{270}

\textit{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.\textsuperscript{271} As discussed further below, pioneer

\begin{itemize}
\item \textsuperscript{268} Id. at 79.
\item \textsuperscript{269} Id. at 98–99.
\item \textsuperscript{270} Christopher D. Hazuka, \textit{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, \textit{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.").
\item \textsuperscript{271} A patent "monopoly," of course, does not guarantee a monopoly in the true sense. See Alan Devlin, \textit{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
\end{itemize}
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.\textsuperscript{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.\textsuperscript{273}

Indeed, some commentators have argued that large dominant firms by their very nature are ill suited to innovate.\textsuperscript{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.\textsuperscript{275} Thomas Edison, for

\textsuperscript{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.").

\textsuperscript{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.

\textsuperscript{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).

\textsuperscript{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.”

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. 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. 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).

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 word, 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. 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. The history of modern technology is littered with examples of wildly inaccurate assessments. Marconi and Deforest, for example, predicted that radio would be

![](image)

...
used only for point-to-point communication; neither foresaw commercial broadcasting as a viable application.\textsuperscript{281} IBM likewise failed to foresee that there would be a commercial market for computers.\textsuperscript{282} And the transistor was expected to make a splash primarily in the hearing aid market.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{286} To obtain a license, a

\textsuperscript{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.

\textsuperscript{282} See Merges, supra note 97, at 86 n.41.

\textsuperscript{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).

\textsuperscript{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).

\textsuperscript{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).

\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{289}

\textbf{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.\textsuperscript{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

\textsuperscript{287} \textit{U.S. Patent Statistics Chart Calendar Years 1963-2010, supra} note 90.

\textsuperscript{288} See Brian J. Love, \textit{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.

\textsuperscript{289} See Lemley, supra note 73, at 1053 (citing \textit{Jay Dratler, Jr., Licensing of Intellectual Property} §§ 1.01(2), 1.04(1) (1996)).

\textsuperscript{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, \textit{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

292. Id. at 881.
293. Id. at 885–88 (detailing General Electric’s domination of the nascent electrical lighting industry).
share grew from forty to seventy-five percent.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{301}
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, 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. 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.

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 rates 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.

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 Boldrin & 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.

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. Broad rights, therefore, may allow a pioneer to hold up multiple generations of later-developed technology.

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. Inventions in these areas are circumscribed and do not lend themselves to radical improvement. 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 industry—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 BOLDRIN & 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, and cells used for medical diagnosticts 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. 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.

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. 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/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_apus.fastagenescan.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. Moreover, many promising areas of biomedical research are subject to a truncated FDA approval process or subject to no approval process at all. 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.

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. 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.”

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324. See ALFONSO GAMBARDELLA, 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; 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. 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. 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.

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. BOLDRIN & 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.\textsuperscript{330} Since that time, universities have obtained thousands of patents per year,\textsuperscript{331} excluding the public from the benefits of research that was incentivized ex ante with funds from the public coffers.\textsuperscript{332} Further, studies show that universities are ill equipped to license their patent rights, as very few universities profit from their patent licensing programs.\textsuperscript{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 548 (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).


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. 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. 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. Thomson, who conducted his research at the


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.

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

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\(^{337}\) 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.").


\(^{340}\) 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 cells—has impeded hES cell research in the United States and led many researchers to leave the country entirely.

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. 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. 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

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.”).


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. 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.

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. 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. 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.

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–S52 (discussing Myriad’s threats of suit and trade sanctions to four Canadian provinces); id. at S54–S57 (discussing Myriad’s efforts to enforce its patent rights in Europe, Australia, and New Zealand).
marketing in new comprehensive tests. 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. 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.

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,
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. 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.

To the contrary, the history of innovation strongly suggests that "pioneer" inventions and "heroic" inventors are nothing more than modern-day technological mythology. 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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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

\textsuperscript{355} This is very likely what the Federal Circuit panel believed it was doing in \textit{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.

\textsuperscript{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. \textit{See} Christopher M. Holman, \textit{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”).

\textsuperscript{357} See generally Vermont, \textit{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 \textit{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. \textit{See} Evans \textit{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.