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June 18, 2012

Illuminating Innovation: From Patent Racing to Patent War

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* J.D., Yale Law School; M.A., University of Chicago; Associate Professor of Law, Indiana University Robert H. McKinney School of Law. Credit is due to Jack Balkin, Laura DeNardis, and all my colleagues and students at the Information Society Project at Yale Law School for providing the initial inspiration for this project, and substantial encouragement during its evolution. Particular thanks are due to my colleagues at Hofstra, especially Rose Villazor, Liz Glazer, and the members of the Junior Faculty Forum, as well as to Dennis Corgill, Eric E. Johnson, Mark Lemley, Gerard Magliocca, Lisa Larrimore Ouellette, and George Wright for very helpful comments. Particular thanks are also due to Joseph Blocher, Samuel Buell, Laurence Helfer, Jerome Reichman, and the participants of Duke Law School’s Legal Theory Workshop for their insightful feedback on an early version of this article. And to David S. Levine for the opportunity to present this work on his Stanford University radio show, Hearsay Culture, www.hearsayculture.com. This Article is made available to the public under the terms of a Creative Commons-Attribution license; a digital copy may be downloaded at no charge from the Social Sciences Research Network at: http://ssrn.com/abstract=1658643.
ABSTRACT

Patent law assumes that stronger protection boosts innovation. Yet empirical evidence to test this “innovation hypothesis” is lacking. This Article argues that historical case studies hold unique promise to provide an empirical foundation to patent law. The Article then offers such a case study focused on electrification. Specifically, this Article uses the history of patent prosecution and litigation surrounding the lightbulb to examine a recently articulated theory of “patent racing” as a justification for patent protection.

As put forth by Mark Lemley, racing theory suggests that patent protection raises the stakes of being the first to reach a technological milestone, and can thus encourage faster innovation. Edison’s experience suggests that Lemley’s racing model has substantial descriptive merit, capturing an important dynamic of patent law’s impact on innovation within a competitive field. Yet a fuller look at the lightbulb case study also shows the limits of the racing model. Looking past the initial “finish line” of patenting to later litigation, the competition looks less like a race and more like a war.

Building on this insight, the Article offers a new model of patent strategy resembling the board game Risk! in which competing parties assemble strategic assets, then turn to battle their rivals for world domination. Similarly, innovative technology companies assemble patent portfolios—initially for defensive purposes in the context of a competitive field. As the industry matures, dominant players turn their patent portfolios into weapons for eliminating the competition. This new “patent warfare” model also helps to explain the impact of patent law on innovation today. Just as nineteenth-century companies in the early electrical industry fought to control the lightbulb, a new patent war is now emerging to control the smartphone.

Importantly, the patent warfare model offers a less optimistic view of patent law’s impact on innovation than the racing model. The initial benefits of patent racing may quicken innovation over the short term. But once the competition turns to patent war, a negative impact emerges. Patent litigation becomes the means to consolidate a highly competitive, dynamic, innovative industry into the hands of a single player. In this way, patent law ultimately brings to an end the very competitive pressure that initially motivated faster innovation under the racing model. This anticompetitive endgame raises concern for future innovation in the information technology (IT) industry, and calls into question the “innovation assumption” at the heart of patent law.
INTRODUCTION

More than a century after its introduction, the incandescent lightbulb remains the defining icon of invention. Elegantly simple, this humble device was nonetheless a transformative technology. Just as spreadsheet software drove demand for personal computers and email clients drove demand for Internet service, the incandescent lamp was the “killer app” that drove demand for electricity. In the process, the lightbulb paved the way for every other electronic appliance; including the radio, the television, and the personal computer. No less than the computer, the lightbulb revolutionized our world.

This article illuminates the role that patent law played in the lightbulb’s emergence. The story told in this Article is not the conventional tale of great inventors, bright ideas, and the inevitable march of scientific progress. It is a story of corporate maneuvering and high-stakes litigation, as Thomas Edison and his competitors employed patents as weapons in their battle to dominate the electrical industry. Although famous for his workshop talents, Edison would be better understood as an early Bill Gates, his business success built on a keen appreciation of the power of aggressive intellectual property strategy and the frailty of antitrust law.

The story of the lightbulb litigation holds particularly important lessons for the modern information technology (IT) industry, where an epic patent battle is now brewing. The smartphone is today’s

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2 See Arthur A. Bright, Jr., The Electric-Lamp Industry: Technological Change and Economic Development from 1800 to 1947, at 8-11 (1949) (explaining the importance of the incandescent lamp to the emergence of an electrical supply system, scientific and public interest in electricity, the radio, and economic growth up through WWI generally).


lightbulb. A complex machine, developed through the collaborative and competitive efforts of many engineers, rather than a single mythological inventor. The subject of patent claims too numerous to count, many of those claims of dubious validity. An everyday, familiar piece of technology, upon which an entire field of future innovation happens to depend. A prize worth untold fortunes to the victor who manages to secure control of it. Understanding the patent war over the lightbulb can help us understand what is at stake in the current one over the smartphone.

Edison’s lamp can also shed light on one of the most important and challenging questions asked in patent scholarship today. For more than two centuries, U.S. patent law has assumed that patents promote innovation. Yet for all the profound impact that patent law has on industry and society, we have little empirical evidence to test this “innovation assumption.” In fact, there are good reasons to believe that patents may also impede innovation, by creating barriers to competition. The assumption should more prudently be treated as a hypothesis in need of empirical testing. Is patent protection on the whole helpful or harmful to innovation? And how might the law be tweaked to achieve an even better balance between protection and competition? The lightbulb can shed light on these questions by testing existing theory, and helping to improve on it.

Part I of this Article, “Testing the Innovation Hypothesis,” argues that careful case studies, particularly ones drawn from history, may best advance our understanding of patent law’s impact on innovation. The remainder of the Article develops such a case study, focusing on Thomas Edison’s efforts to market an incandescent lightbulb. Part II, “Dynamics of Inventive Racing,” takes up a recently articulated theory of patent racing, using the case study to test and refine the model. Part III, “Learning from the Lightbulb,” explores the lessons of this case study for the innovation hypothesis. Here, a new model of “patent warfare” is advanced, which not only explains the experience of the early electrical industry, but also illuminates the stakes of the new patent war now brewing in the smartphone industry.

http://online.wsj.com/article/SB10001424052702303879604577414832794580586.html (“Chief executives… will meet in San Francisco Monday in a court-directed session aimed at settling their smartphone patent war. But a deal seems unlikely, people familiar with the matter and others tracking the battle say.”); Marissa Oberlander, Martin Stabe and Steve Bernard, The smartphone patent wars, FINANCIAL TIMES, October 17, 2011, (“Patent wars are raging in the smartphone industry. What began as Apple v. Google Android conflict has turned into a vast legal quagmire involving everyone from Amazon to ZTE.”)
I. TESTING THE INNOVATION HYPOTHESIS

A. Patents & Innovation

For more than two centuries, the notion that patent protection encourages technological innovation has remained the conventional wisdom. In 1830, Anglo-American legal philosopher Jeremy Bentham captured its essence: “In new inventions, protection against imitators is not less necessary than in established manufactures protection against thieves. He who has no hope that he shall reap will not take the trouble to sow.” A half-century later, the same notion shows up as the popular wisdom of industrial Americans in Mark Twain’s A Connecticut Yankee in King Arthur’s Court. In this tale, a New England mechanic from the 1880s travels back in time to Camelot, where he becomes a valued advisor to the English king. On the subject of technological innovation, Twain’s hero relates: “the very first official thing I did, in my administration—and it was on the first day of it, too—was to start a patent office; for I knew that a country without a patent office and good patent laws was just a crab, and couldn’t travel any way but sideways or backwards.”

As an empirical matter, however, the benefits of patent protection for innovation are far less certain. Scholarly skepticism about the

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5 This notion is reflected in the constitutional foundation of patent protection. The U.S. Constitution provides that Congress may offer inventors monopoly privileges on their inventions, for limited times, “to promote the Progress of Science and useful Arts.” U.S. Const. art. I, § 8, cl. 8. At the Constitution’s signing, a number of States were already granting patents and some had done so even as British colonies. BRUCE W. BUGBEE, GENESIS OF AMERICAN PATENT AND COPYRIGHT LAW 60-103 (1967). The true effect of this constitutional provision, then, was not to create a governmental power to grant monopolies, but to establish this power as an exclusively federal one, to be exercised by the legislative branch. Whether the provision also established meaningful limits on the term of such monopolies is a topic that remains open to substantial debate.

6 JEREMY BENTHAM, THE RATIONALITY OF REWARD 318 (1830).

7 MARK TWAIN, A CONNECTICUT YANKEE IN KING ARTHUR’S COURT (1889). Credit is due to Mark Adelman for leading me to Twain’s work. For a more serious interview with Mark Twain suggesting that the Yankee hero’s statement reflects Twain’s own beliefs rather than simply words thrust upon a satirical strawman, see MARK TWAIN & GARY SCHARNHORST, MARK TWAIN: THE COMPLETE INTERVIEWS 295 (2006) (using historical evidence himself to suggest that patent protection encourages not so much invention itself as the diligent perfection of invention into a commercially practical technology). Twain was also a patent holder. Mark Twain, Improvement in Scrapbooks, U.S. Patent No. 140,245 (filed May 7, 1873) (issued June 24, 1873).
anticipated benefits of patent protection also has deep roots.\textsuperscript{8} It has long been recognized that patent protection may undermine incentives to further develop and improve existing technologies.\textsuperscript{9} In the 1950s, a noted economist advised Congress: “If we did not have a patent system, it would be irresponsible, on the basis of our present knowledge of its economic consequences, to recommend instituting one. But since we have had a patent system for a long time, it would be irresponsible, on the basis of our present knowledge, to recommend abolishing it.”\textsuperscript{10} Fifty years later, the noted law-and-economics scholar Richard Posner lamented that economists have still not determined whether the benefits of intellectual property protection outweigh its costs.\textsuperscript{11} Economists and legal scholars have recently devoted great theoretical attention to clarifying the ways in which patent protection may inhibit, as well as incentivize, innovation.\textsuperscript{12} A recent work by


\textsuperscript{11} See, e.g., Richard A. Posner, \textit{Intellectual Property: The Law and Economics Approach}, 19 J. Econ. Persp. 57, 59 (2005) (“Unfortunately, economists do not know whether the existing system of intellectual property rights is, or for that matter whether any other system of intellectual property rights would be, a source of net social utility, given the costs of the system and the existence of alternative sources of incentives to create such property.”).

James Bessen and Michael J. Meurer concludes pessimistically: “Innovation may occur Despite the patent system.”

Patent law and policy, however, continue to operate on the assumption that patents incentivize substantially greater innovation. Even most contemporary patent scholars treat this assumption as presumptively correct, while allowing for the possibility that future research might one day call it into question. This willingness to assume—at least for the time being—that patents work as intended has the same practical effect as an evidentiary presumption: it shifts the burden of proof onto the challengers of the conventional wisdom.

There are virtues to adopting this presumption. One such virtue is enabling patent scholars to focus productively on calibrating less entrenched aspects of patent doctrine, and on suggesting reforms that may be implemented in the near future. Embracing this assumption too fully, however, carries an unacceptable risk. Patent law is a tremendously influential aspect of modern economic regulation. What

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33 “It is important to emphasize that our evidence suggests that patents today constitute a brake on innovation, not a roadblock... Our evidence implies that patents place a drag on innovation. Without this drag, the rate of innovation and technological progress might have been even greater, perhaps much greater.” James Bessen & Michael J. Meurer, Patent Failure: How Judges, Bureaucrats and Lawyers Put Innovators at Risk 145-46 (2008).

34 Indeed, evidence suggests that patent law’s reliance on the innovation assumption has, if anything, increased in recent years. See Gaia Bernstein, In the Shadow of Innovation, 31 Cardozo L. Rev. 2257 (2010) (documenting an increasing use of the phrase “innovation” in intellectual property opinions beginning in the 1980s).

if its central assumption is wrong? So far we have justified the substantial social costs of patent protection—litigation costs, anticompetitive effects, higher prices for consumers, barriers to adoption of new technologies—on the basis that these sacrifices are worthwhile in order to achieve faster innovation. If patent protection offers much smaller benefits for innovation than widely supposed, the law is imposing these substantial costs needlessly. And if patent protection actually has a net negative impact on innovation, the real costs to economic growth may be appalling in scale. Because the risks of being wrong are so great, the innovation assumption should more prudently be treated as the innovation hypothesis—one urgently in need of empirical testing.

B. Case Study as Methodology

A major challenge for researchers seeking to test the innovation hypothesis is the very complexity of the phenomenon. Changes in patent policy take time to play out in the marketplace, and affect different industries in different ways. At the macroeconomic level, it can be very difficult to separate out impacts due to changes in patent policy from those due to other causes. Cross-national comparisons are further complicated by the trend toward harmonization of patent law, which limits opportunities for empirical evaluation of differing regimes. Even defining “innovation” as a quantifiable outcome has proven elusive. These challenges make it difficult to reliably measure patent law’s impact through large quantitative studies.

16 Economist Petra Moser has creatively approached this problem, by analyzing evidence of innovation predating the modern trend toward international harmonization of patent law. Petra Moser, *How do Patent Laws Influence Innovation? Evidence from Nineteenth-Century World’s Fairs*, 95 AM. ECON. REV. 1214 (2005) (concluding that patent protection appears to enhance innovation in some industries but impede it in others; Moser recommends that variance in patent regimes across countries may result in optimal global results by encouraging the development of comparative advantages).

In an earlier article, I explored some of the problems inherent in macroeconomic measures of innovation, and recommended an alternative approach. Rather than crunch numbers of dubious accuracy and relevance, that article suggested, careful case studies may prove more enlightening at the present stage of research on innovation. A case study steps back from the overwhelming web of data to pick up the thread of a single "case," which might be the life of a particular patent, technology, company or industry. The researcher follows the path of that one subject to see where it leads and attempts to interpret its lessons. A leading articulation of the case study methodology in the social sciences proposes that "case studies are the preferred method when (a) ‘how’ or ‘why’ questions are being posed, (b) the investigator has little control over events, and (c) the focus is on a contemporary phenomenon within a real-life context." These three conditions accurately capture the challenges associated with asking how patent law impacts technological innovation.

Within the substantial social scientific literature employing and commenting on the case study methodology, some researchers prefer case study methodology because of normative commitments that achieving objective, accurate explanation of complex social phenomena is unattainable or undesirable. From these researchers’


19 The empirical “case study” has no necessary relationship with the “case method” widely used in legal research and education. Literature on case studies as an empirical research methodology has been careful to distinguish its subject from the quite different use of cases as a teaching tool in law and business. See, e.g., Yin, supra note ___ at 4-5. In contrast to the case method, the case study need not take a particular legal dispute or judicial opinion as its focus of inquiry. Of course, the “case” that is the object of empirical study might be a legal case, such as the Supreme Court’s hearing of the Incandescent Lamp Case. But the “case” might also be a patent (such as Edison’s ‘898 patent), a technology (the lightbulb), a patentee (Thomas Edison), a firm (General Electric), or a sector (the early electrical industry). Any specific, complex, functioning thing may be a “case” for study. See Robert E. Stake, The Art of Case Study Research 2 (1995). My interest in understanding how patent law influences technological innovation led me to define my case around one technology—the early lightbulb. Many different legal disputes, patents, patentees, and firms would influence innovation in any particular field of technology. Therefore, focusing on any one particular opinion, patent, inventor, or company would likely narrow the inquiry too much and miss essential aspects of the larger innovation dynamics. A concrete technology (such as the lightbulb, or the smartphone) appears to be the simplest unit of investigation that allows us to seek answers to questions about technological innovation and diffusion, without hiding the complex operations of patent law in the real world.

point of view, there is no “truth” in social science, only “interpretation.” This is not my point of view, nor is it my motivation for adopting the case study methodology. Quite to the contrary, this study assumes that there is a correct answer to the question “Does patent protection promote technological innovation?” and that social science can help us find that correct answer. (Such an answer may of course be deeply complex, filled with caveats, and inevitably have some margin of uncertainty. The answer is likely to be: “Under certain circumstances, yes, probably; and under other circumstances, no, probably not.”) Careful case studies can help illuminate these complex dynamics and form provisional answers to these questions, which may in turn be further tested and verified through other research methodologies, including quantitative analysis. Yet it must also be acknowledged that case studies are fundamentally acts of interpretation. To guard against investigator bias, these interpretations should be subject to peer review, public debate, and independent studies of other cases, a phenomenon referred to in the case study literature as “triangulation.”

To be sure, a case study of any one technology has only limited utility for answering our larger questions about innovation. The dynamics of the particular technology selected may not be representative of all sectors or even of the general trend. Over time, however, the collective work of many scholars may build a robust body of case studies, which could provide a strong empirical basis to support or call into question key predictions and beliefs. Even before this critical mass is reached, individual case studies can offer a helpful “reality check” on our theoretical models of how patent incentives are believed to work. Do theoretical predictions that seem to make sense in the abstract actually fit with what can be observed in the historical record? Or is there a significant gap between theory and fact, at least in the particular cases available to date? Case studies can also offer quantitative researchers insight into how to construct more valid large-scale empirical research, by illuminating factors and causal pathways whose importance might previously have been overlooked.

Empirical case studies have already been developed by patent scholars looking at number of modern technologies. For example, Lisa Ouellette has examined the disclosure function of patents in spreading scientific knowledge through the nanotechnology sector. See, e.g., ROBERT E. STAKE, THE ART OF CASE STUDY RESEARCH 111-15 (1995)


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Merges, Samuelson and Sichelman have drawn findings about the role of patents in assisting startups, drawing on surveys of more than one thousand high-tech entrepreneurs in sectors ranging from biotechnology to software. Samuelson and Scotchmer have examined the economic impact of reverse engineering in the semiconductor and software industries. Health economist Heidi Williams has used interviews and statistical analysis to document a negative impact on downstream innovation for gene sequences covered by intellectual property. Fiona Murray and colleagues document a similar negative impact in a comparison of laboratory mouse varieties subject to differing intellectual property restrictions. The above case studies each have a quantitative component, focusing on a particular set of data to answer particular questions about their cases. These illustrate the point that the case study need not be purely qualitative.

A more recent development in patent scholarship is to explore historical, as well as current, case studies. Thus Gerard Magliocca


27 There is also a larger body of historical work on patent law not employing the case study approach. See, e.g., B. ZORINA KHAN, THE DEMOCRATIZATION OF INVENTION: PATENTS AND COPYRIGHTS IN AMERICAN ECONOMIC DEVELOPMENT (2005); CHRISTINE MACLEOD, INVENTING THE INDUSTRIAL REVOLUTION: THE ENGLISH PATENT SYSTEM 1600-1800 (1988) (examining trends in patenting and innovation as well as offering an intellectual history of the concept of invention in this time period); Brad Sherman & Leanne Wiseman, Fair Copy: Protecting
has harvested lessons from the behavior of patent trolls in nineteenth century agricultural machinery. Adam Mossoff has delved into patent thickets surrounding the early sewing machine industry. Kara Swanson has revealed the hidden dimensions of “the corset case” to offer a gendered perspective on patent law. And Christopher Beauchamp picks up the telephone as an object of cultural and legal disputes over inventorship. So far, historical scholars have not focused centrally on the innovation hypothesis; and innovation scholars have not favored historical case studies.

Historical inquiry comes with challenges for the researcher interested in impacts on innovation. Quantitative data may not have been recorded, and may be impossible to gather now. Participant observation and interview are similarly unavailable as methodologies. Despite these limits, historical case studies are crucial for testing patent law’s innovation hypothesis. The unique advantage of a historical case study is that it allows us to observe both short-term and long-term results. This is essential because the full impact of patent protection plays out over several decades. In the near term, incentives are perceived, a technology is developed, patents are issued, and products come to market. In the longer-term, the new industry matures, litigation ensues, the first-generation patents expire, and second-generation innovation takes place. When studying cutting-edge technological sectors, our analysis is necessarily limited to the


near term; the longer-term effects remain in the future, out of sight. This shortened horizon may introduce a systematic blind spot in our understanding of patent law’s true impact. The benefits of patent protection are visible immediately, in the form of enhanced research and development spending, cutting-edge technologies, and new products on market. The long-term costs to competition, access, and next-generation innovation may take place later, out of sight.\(^{32}\)

Taking a historic case study such as the lightbulb allows us to examine the impact of patent law in the fullness of time—not just at the R&D stage, but throughout the term of protection and past its expiration. We may thus be able to observe long-term dynamics that would have remained hidden if studying a more current technology. In the case of the lightbulb, such long-term dynamics included epochal litigation, the consolidation of a previously competitive industry, and a half-century lull between when the technology was patented and when it finally became widely accessible to the American public. Perhaps it should come as no surprise, then, that patent scholars centrally concerned with the innovation problem have heavily relied on the limited historical research currently at hand.\(^{33}\) History remains the best evidence available to us, in a world where controlled experiments are impossible. This promising body of evidence deserves more careful investigation.

C. Law and the Lightbulb

Why choose the lightbulb over any number of alternative candidates? Robert E. Stake has distinguished three approaches to case study research: “intrinsic, instrumental, and collective.”\(^{34}\) First, a researcher may choose to undertake a case study for intrinsic interest: not to understand a general phenomenon or build theory, but because

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\(^{32}\) See generally Gaia Bernstein, *In the Shadow of Innovation*, 31 Cardozo L. Rev. 2257 (2010) (distinguishing the first step of innovation from the second step of diffusion, and arguing that intellectual property law has been insufficiently concerned with the latter).


the case itself is of inherent interest. Alternatively, a case may be explored with the primary goal of gaining understanding into larger questions removed from the particular instance—the instrumental case study. My aim in undertaking this case study is decidedly instrumental; my research is driven by the desire to understand how patent law impacts technological innovation and diffusion. Many different inventions could have served that instrumental purpose; the lightbulb offered simply one convenient starting point. In the future, several thoughtfully selected inventions might be explored through a collective case study.

For many Americans, however, the case of Thomas Edison and the lightbulb holds substantial intrinsic interest. People are interested in knowing more about the invention of the lightbulb, for its own sake. Choosing this particular case thus offered me a vehicle to explore the innovation hypothesis, with the hope of finding a wider audience. A second advantage of the enduring intrinsic interest in the light bulb and Thomas Edison is that a substantial body of scholarship already exists on this case. This Article draws significantly on that existing scholarship to look for answers to a previously neglected research question. The easy availability of both primary and secondary materials on this case also means that researchers who share my interest in the innovation hypothesis have access to the same resources. Others may interpret these materials independently, critique my conclusions, and offer alternative explanations.

Discussion of Edison’s work seems an almost inescapable element of any treatise on innovation. So far, however, the Great Inventor

35 Id. at 437.

36 Id.

37 See id. (defining the collective case study as an instrumental study extended to several cases, which are selected as a sample to be representative of a broader class of phenomena the researcher wants to understand).

has attracted little sustained attention from legal scholars. The Supreme Court’s opinion on the Incandescent Lamp Patent is familiar to many patent attorneys, students, and scholars. It is excerpted in several patent casebooks and makes regular appearances in law review footnotes. Yet the case’s historical context, the litigation’s implications for the electrification of America, and the case’s potential larger lessons for innovation policy remain only dimly unappreciated. More often, we invoke Thomas Edison and his lightbulb in passing—treating Edison as icon, rather than as a subject of inquiry.

The exception that proves the rule: Barak Y. Orbach, Prizefighting and the Birth of Movie Censorship, 21 YALE J.L. & HUMAN. 251 (2009) (extensively examining Edison’s role in adopting self-regulation as a mode of content censorship in the early motion picture industry). Orbach’s interest was censorship and freedom of expression, yet his article’s insight into Edison’s business approach to motion picture technology is interesting from an intellectual property perspective as well. Id. For instance, Orbach traces Edison’s tendency to publicly exaggerate the progress of an invention, and his inability to accurately predict the profitability of a technology at the time of its invention. Id. at 275. Edison also receives several paragraphs of attention in recent works by Mark Lemley and Brian Love; these works are discussed in detail in Part II of this Article.

Consol. Elec. Light Co. v. McKeesport Light Co., 159 U.S. 465 (1895). The case quickly became known by the subject matter of the patent, rather than the parties’ names. See, e.g., WALTER MALINS ROSE, NOTES ON THE UNITED STATES REPORTS: A BRIEF CHRONOLOGICAL DIGEST OF ALL POINTS DETERMINED IN THE DECISIONS OF THE SUPREME COURT 776 (1905) (referring to the case by the name of “Incandescent Lamp Patent” and summarizing the holding as “Patent is void, where application is so vague that independent experimentation is necessary to construe it.”). See, e.g., Joshua D. Sarnoff, The Historic and Modern Doctrine of Equivalents and Claiming the Future, Part II (1870-1930), 87 J. PAT. & TRADEMARK OFF. SOC’Y 441, nn. 121-27 (2005) (crediting the case with establishing the modern standard for enablement of claim scope, laying to rest earlier doctrine on pioneering patents); Mark A. Lemley, The Economics of Improvement in Intellectual Property Law, 75 TEX. L. REV. 989, 1002 (1997) (referring to it as “a celebrated case” illustrating the principle that patent claim scope should be limited to embodiments actually enabled by the disclosure); Dmitry Karshtedt, Limits on Hard-to-Reproduce Inventions: Process Elements and Biotechnology’s Compliance with the Enablement Requirement, 3 HASTINGS SCI. & TECH. L. REV. 109, 140 (2011) (citing “the venerable Incandescent Lamp Patent case” as indicative of the genus-species rule of patent claiming).

Before beginning this deeper inquiry, a brief introduction is in order. Many of us were taught as children that Thomas Alva Edison invented the lightbulb. The full story is more complicated. A primitive lightbulb had first been demonstrated more than seventy years before Edison’s work began. In the intervening decades, crucial improvements in vacuum technology and electricity generation were developed that made electric light a newly promising technology. Beginning in 1878, Edison led a team of engineers who worked together to produce one of the first commercially practical systems of interior lighting. This team, however, had serious competition. The competition was so intense, in fact, that for many years after lightbulbs began to be widely manufactured and sold, it was unclear who had won. Even today, British schoolchildren are taught that Joseph Swan, not Thomas Edison, won the race to invent the lightbulb. Once electric light was ready for commercialization, many companies competed with Edison’s in the marketplace. Compared to


42 A number of works aimed at children present Thomas Edison as an archetype of the heroic inventor. See e.g., LAURIE CARLSON, THOMAS EDISON FOR KIDS: HIS LIFE AND IDEAS: 21 ACTIVITIES (2006); NELLIE CANFIELD MCFEE, THE STORY OF THOMAS A. EDISON FOR YOUNG READERS (1922); FRANCIS ROLT-WHEELER, THOMAS ALVA EDISON (1915); WILLIAM HENRY MEADOWCROFT, THE BOY’S LIFE OF EDISON (1911).

43 At the exhibitions of the International Electrical Congress in Paris in 1881 – held after Edison had filed several patents in the field but before he had his first paying customers – incandescent lamps were displayed by Swan, Lane-Fox, Maxim and Edison. THOMAS P. HUGHES, NETWORKS OF POWER: ELECTRIFICATION IN WESTERN SOCIETY 1880-1930, at 50 (1983) (citing 32 ENGINEERING 534 (1881)).

44 This version of history is reflected in the Wikipedia entry for Joseph Swan. See also KENNETH R. SWAN, K.C., SIR JOSEPH SWAN 16-39 (1946) (denouncing at the outset “the somewhat pretentious and all-embracing claims which have from time to time been advanced on Edisons behalf” and providing a detailed account of Swan’s own claim to inventorship of the incandescent lightbulb).
his rivals, however, Edison was particularly successful in litigating his patents. Edison’s leveraged his patent portfolio and courtroom successes to obtain mergers or market sharing agreements with most of his competition. A fifteen-year litigation campaign produced a stunning consolidation of a previously competitive market for lightbulb manufacture. By 1910, General Electric—the successor to Edison’s electric light companies—would control 97% of all lightbulbs sold in the U.S. market. The remainder of this article examines both the early patent race and the later patent war in greater detail.

II. DYNAMICS OF INVENTIVE RACES

One contribution historical case studies can make is to test existing theoretical models of patents’ role in incentivizing innovation. Part II of this Article uses the case study of the lightbulb to test, critique, and refine the theory of “patent racing,” which has been offered as one account of how patent protection may incentivize faster innovation. As articulated by Mark Lemley, patent racing theory centers on an underappreciated fact that proves problematic for other theories of patent-motivated innovation: most inventions are not breakthroughs at all, but ordinary engineering work that achieved its goal just a short time before the rest of the competition.

In using the lightbulb case study to test this theory, this Article draws upon a vast secondary literature describing the development of the lightbulb. This historical literature, however, predates patent racing theory, tends to discuss patents and patent law only tangentially, and is generally authored by writers more interested in Thomas Edison as a personality than in theoretical questions of innovation policy. The process of sifting through this literature is thus one of searching for needles in a haystack—finding those snippets of relevant information here and there in the corpus, historical asides which now enjoy a second life as data points completely unintended by their original documenters. In all cases I have made a point to critically question whether the original author’s account of the historical “facts” should be treated as reliable or not. As much as possible, this account relies only on data that can be confirmed through reference to more than one source.

45 BRIGHT, supra note 2, at 147-48.

Held up to the empirical light of Edison’s bulb, Lemley’s patent racing model proves to have substantial merit as a descriptive account. The racing metaphor captures a significant and often overlooked reality about the dynamics of innovation in the shadow of patent law, and is helpful to understanding the development of the lightbulb. In its present form, however, patent racing theory also has weaknesses. A closer look at the lightbulb suggests that the better metaphor for understanding technological innovation may be neither a sprint nor a marathon, but the board game Risk! Patent law does not provide clearly defined finish lines and criteria for judging winners, but rather a set of strategic resources for waging longer-term corporate battles. Ultimately, the experience of the lightbulb leaves me less optimistic than Lemley that patent racing will fare any better as a normative justification for patent protection. Rather, a fuller understanding of the inventive race to control the lightbulb should leave us even more skeptical of the innovation hypothesis.

A. The Theory of Patent Racing

In The Myth of the Sole Inventor, Mark Lemley explores the underappreciated dynamic of “simultaneous invention,” and the problems it poses for the conventional economic justifications of patent protection. In case after case, Lemley’s article illustrates, multiple inventors, working on the same technological problem, have arrived at the same solution at nearly the same time. The archetypal case here is the telephone: Alexander Graham Bell and Elisha Gray reportedly filed their competing patent applications on the very same day. Simultaneous invention may also take a less obvious form, wherein a single product builds on incremental inventive

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47 I am indebted to Robin Feldman for the invitation to think of patent rights not as property claims in the traditional sense, but as a ticket to be present at the bargaining table as shares of ownership in a technology are eventually being resolved. My theory of patent warfare builds on this view of patent strategy, although the metaphor I have chosen reflects a view of the dynamic as less collaborative and more destructive than her own.


49 Id. at 56-57.

50 Id. at 4, 22-25, 83.
contributions by so many different parties that it truly has no identifiable inventor.\textsuperscript{51}

The overwhelming presence of simultaneous invention, Lemley argues, calls into question the dominant theoretical justifications for patent protection. If invention is the product of ordinary engineering work rather than extraordinary labors of genius, why do we award such an enormous prize to the party that achieved it first, if only by a few days?\textsuperscript{52} Lemley then proposes an alternative theory that might better justify patent protection, which begins from the reality of simultaneous invention, rather than from the myth of the sole inventor. This “patent racing” theory proposes that patent incentives accelerate innovation by increasing the stakes of the race to invent. All parties in the competition know that the first-place winner will take away a great prize, and the runner-up may be shut out completely. The enhanced competition these heightened stakes engender, Lemley suggests, may motivate greater investment of resources and thus accelerate the overall pace of innovation.

The Myth of the Sole Inventor actually includes the lightbulb among its historical examples of simultaneous invention, along the incremental model. Lemley correctly characterizes Edison’s inventive contribution as “one in a long chain of improvements.”\textsuperscript{53} A closer look at the development of the incandescent lightbulb reveals strong support for some aspects of patent racing theory, and also suggests ways in which the framework requires complication and revision.

\textbf{B. Support for Patent Racing Theory}

First, the support: Thomas Edison was clearly in an inventive race. He had multiple contemporaneous rivals pursuing the exact same inventive goal: a commercially viable lightbulb. According to Conot, at least 31 U.S. Patents in the area of incandescent light had already been granted and not yet expired.\textsuperscript{54} Edison thus began work on the incandescent lightbulb in 1878, at a time when the field was already

\begin{itemize}
  \item \textsuperscript{51} \textit{Id.}
  \item \textsuperscript{52} \textit{Id.} at 53-55.
  \item \textsuperscript{53} \textit{Id.} at 4, 25-27, 84. Lemley characterizes Edison’s inventive contribution as “an incremental one: one in a long chain of improvements.” \textit{Id.}
  \item \textsuperscript{54} BAZERMAN, supra note \textsuperscript{\text}, at 247 (citing ROBERT E. CONOT, STREAK OF LUCK 214 (1979)).
\end{itemize}
populated by competing inventors and prior patents. This competition continued after Edison entered the field, and multiple parties filed important patents in the United States and other jurisdictions. Edison would begin large-scale electric light service in New York City in September 1882. By that point, several other companies were also mass-producing electric lightbulbs—and wielding their own patent portfolios.

Offering further support for the validity of Lemley’s metaphor, these parties also perceived themselves to be in a race. They were acutely self-conscious about their competition, sought out every available bit of information about the other teams’ progress, and were generally quite concerned about who seemed to be ahead at any given moment. So were their investors. Edison was particularly concerned about the progress being made by the team of William Edward Sawyer and Albon Man. Between 1880 and 1883, the competitors were embroiled in a hard-fought priority battle at the US patent office over which team had been first to achieve a key insight. The dispute went against Edison, and the Sawyer-Man’s patent’s issuance in 1885, along with Westinghouse’s entry in the industry, set the stage for a decade of extensive and expensive litigation.

Given the existence of other competitors, one very plausible interpretation of this history that Edison’s participation in this race merely accelerated the arrival of a commercially practical lightbulb. Gas lighting was an extremely lucrative industry, and arc electric lighting was already finding commercial application. The immense market potential of electric light in the household context was widely realized. For electric engineers of the day, the challenge of “subdividing the electric light”—adapting it for domestic use—was an obvious goal, attracting significant attention and effort even before Edison entered the field.

55 See Friedel & Israel, Biography of an Invention, supra note __, at 7-8 (“As early as 1841, Frederick De Moleyns, an Englishman, received a British patent for an incandescent lamp using both carbon and platinum. In 1845 an American, J.W. Starr, not only patented two forms of incandescent lamp (one using platinum, the other carbon) but also traveled around England giving exhibitions and promoting his inventions.”). See also William Sawyer, Electric Lamp, U.S. Patent No. 235,459 (filed Sept. 20, 1880) (issued Dec.14, 1880) (claiming a particular mechanism for fitting an electric lamp to a bracket).


57 Bazerman, supra note __, at 248.

and of technological groundwork already laid, therefore, a commercially practical lightbulb may have been a near inevitability.

Edison’s participation, however, probably greatly increased the fervor of this race—at least between his 1878 entry and 1881, when Edison moved from Menlo Park to New York to oversee commercial introduction. Prior to Edison’s entry, limited resources were being invested in pursuit of the incandescent lightbulb. The leading American competition was the Sawyer-Man team. William Sawyer was a journalist turned inventor funded primarily by New York lawyer Albon Man, who organized the Electro-Dynamic Light Company for this purpose. The company had allocated $4000 to Sawyer’s research between March and June 1878.\(^59\) Edison’s talent for raising venture capital would produce a much bigger war chest: nearly $130,000 in research funds were directed to his electric lighting work between 1878 and 1881.\(^60\) The promise of patents was key to this deal.

Edison’s entry into the field not only attracted significant new investments to his own team, but also motivated increased investments to his competitors. In September 1878, the precise month that Edison threw his hat into the ring, the Sawyer-Man company set up a second workshop.\(^61\) Indeed, Edison’s entry may have been the defining event that truly kicked off the race for the lightbulb as a serious one. When Edison filed his first lightbulb patent in 1878, he brashly claimed to have the solution already in hand. Stock prices in gas companies tumbled, indicating that at least some took these claims seriously. More sophisticated investors, however, knew better than to take Edison’s initial claims at face value. They suspected that the solution was not yet in hand, and even doubted whether Edison would ultimately be the first to achieve it. Nonetheless, Edison’s claims could not be ignored.

Lemley suggests that patents may increase the incentives in a race as both a carrot and a stick. From the carrot perspective, runners race because they believe that they will finish first and obtain a patent reward. From the stick perspective, runners are motivated to go faster because they fear that their competitors will win, and obtain patent rights that shut them out of a lucrative market. Looking at the race for the lightbulb, the stick dynamic seems to be strongly in play. Edison’s


\(^{60}\) Id. Adjusted for GDP deflation, Edison’s $130,000 in research expenses from 1878-1881 translates to more than $2.5 million in current dollars. Id.

\(^{61}\) Id.
1878 claims represented a threat that he would solve the problem of the lightbulb in the near future. That threat seemed uniquely credible coming from Edison because of his public reputation as an inventor and because of his obviously passionate commitment to this particular technological challenge.  

Edison’s entry into the race on these terms thus helped to create an air of inevitability surrounding incandescent lighting. The perfection of the technology suddenly seemed close at hand. Investors scrambled to pick sides and stake claims in what now appeared poised to be an important new industry. Gas lighting companies stood to come out as losers no matter which team won the race. This made it all the more important for them to throw some of their great resources into backing a winning team, in order to hedge their existing investments. The race was definitively on, and gathering momentum. The key points of Lemley’s theory – the prevalence of simultaneous invention, the role of patent protection in raising the stakes, and the power of competition to motivate increased investments in research and development – all find support in the race to perfect the lightbulb. 

Offering further support for the validity of Lemley’s model, the parties involved also perceived themselves at the time to be in a race. They were acutely self-conscious about their competition, sought out every available bit of information about the other teams’ progress, and were generally quite concerned about who seemed to be ahead at any given moment. So were their investors. Edison was particularly concerned about the progress being made by the team of William Edward Sawyer and Albon Man, and with good reason. Between 1880 and 1883, the competitors faced off in a hard-fought priority battle at the US patent office over which team had been first to achieve a key technological insight. The dispute was ultimately resolved against Edison, and the Sawyer-Man’s patent’s issuance in 1885, along with Westinghouse’s entry in the industry, set the stage for a decade of extensive and expensive litigation.  

C. Problems for Patent Racing Theory

Despite all this support in the historical record, Lemley’s theory of patent racing has been vehemently disputed by business professor

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62 Friedeil & Israel, supra note __, at 29 (suggesting that initially, Edison’s chief asset was self-confidence; largely shared by the world at large).

63 Bazerman, supra note __, at 248.
John Howells and his co-author, Ron D. Katznelson. These critics specifically take issue with Lemley’s use of the lightbulb as an example of incremental invention. They argue that Edison’s contribution in fact “unlocked the field,” cannot be placed on a par with contributions by any other inventor, and was deserving of a “pioneer” patent. My own closer examination of the lightbulb case puts me definitively on the side of Lemley rather than his critics. The central mistake made by Howells and Katznelson is to treat judicial opinions and patent claims as reliable evidence of who really did what. Yes, these legal documents do assert that Edison’s inventive contributions were without peer. Such assertions, however, should be treated with great skepticism. The historical claims about Edison’s invention of the lightbulb, which Howells and Katznelson reprise as fact, are better understood as a deeply mythologized narrative of invention that Edison himself forged in preparation for litigation. The model of incremental innovation more accurately fits the true history of the lightbulb’s development.

My concern with patent racing theory as articulated by Lemley is that it does not yet go far enough to reflect the reality of incremental innovation. Lemley describes simultaneous invention as existing in two modes. One is where two inventors are working on the same technology, and the contest is to see who will produce it first. Lemley offers the telephone as the archetype of a patent race: two inventors almost literally racing to the patent office door. But the second mode is probably more common; where the process invention is characterized by roughly contemporaneous contributions by so many different parties that it becomes impossible to declare any one true

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65 The concept of a “pioneer patent” was popular in American patent doctrine at the end of the nineteenth and early twentieth centuries. Proponents argued that where an inventor had made a “pioneering” contribution to a new field of technology, they should be entitled to broad claims covering not only the specific embodiment they had produced, but even later generations of the technology as developed by others. For a critique of this doctrine – and argument as to its enduring relevance – see Brian J. Love, Interring the Pioneer Invention Doctrine, 90 N. CAROLINA L. REV. 379 (2012), at http://ssrn.com/abstract=1804546.


“father” of the technology. The race for the lightbulb, at least, best fits this pattern of incremental innovation.\textsuperscript{68} Even in the case of the telephone, the narrative of the race to the patent office may be more a product of litigation stance than the underlying reality of technological development.\textsuperscript{69}

If the pattern of incremental innovation is indeed the prevailing one, we need a reconceptualization of racing theory that deemphasizes the patent filing as the finish line. Central to the concept of a race is the existence of a clearly defined finish line, at which point the winners and losers are declared based upon a simple and objective measure of performance. Indeed, the very purpose of the race as an athletic convention is to enable this objectivity, by clearly defining the terms of the contest in advance. A political campaign also meets these two criteria of a traditional race: a clearly defined endpoint (election day) and an objective methodology for determining the winner (tabulating votes). Inventive races, however, may not conform to this model. The race for the lightbulb, at least, lacked these two key characteristics.\textsuperscript{70}

Indeed, this particular race was so closely and fiercely contested that for many years—even years after lightbulbs were widely being bought and sold across the United States—there was no clear winner. Throughout the 1880s, multiple companies, each holding patent portfolios from different inventive teams, claimed strenuously that

\textsuperscript{68} For a comprehensive account of innovations in electrical lighting between 1880 and 1890, well situated in their economic and political context, see generally HUGHES, NETWORKS OF POWER, supra note ___.

\textsuperscript{69} See Christopher Beauchamp, Who Invented the Telephone? Lawyers, Patents, and the Judgments of History, 51 TECH. & CULTURE 854, 877 (2010) (highlighting the difficulty of “the question of where, on the continuum of conceptualization, experimentation, ‘reduction to practice,’ and commercialization, the invention of the telephone should be rightly marked.”).

\textsuperscript{70} The inventive race for the lightbulb does have one other similarity with political races, however: the dynamics of self-fulfilling prophecies. In a political campaign, each contender seeks to create the perception that they are in the lead, in order to win over those potential supporters who simply want to throw in their lot with the likely winner. Edison thus cultivated the media and exaggerated his own progress to discourage investors from backing his rivals. Similar to a political campaign, impressions about which inventive team is ahead can translate into additional resources helpful for getting ahead, making such prophecies self-fulfilling. Mercifully, even the longest political campaign finds its end within eighteen months, and a victor is clearly anointed. Not so with an inventive race, where it may take more than a decade for courts to declare the winner.
their champions were the true originators and owners of the technology underlying the lightbulb. Ultimately these conflicting claims had to be settled by the law. In doing so, courts struggled to apply criteria that are infinitely more complex and subjective than those commonly used to judge athletic and political races. Courts also had to make this determination not immediately after the relevant finish line, but many years after the relevant facts had occurred, upon an imperfect evidentiary record. The standards were subject to significant interpretation, and the facts were developed by deeply interested parties, often with disparate resources.

The nature of the competition in an inventive race may therefore be much less objective and meritocratic than the metaphor initially suggests. Are inventive races meaningfully similar to the 100-meter dash or a presidential primary? Or are they more like an Olympic gymnastics competition, in which the American and Soviet judges may arrive at wildly different conclusions? This is not at all unrealistic. After all, American courts picked Thomas Edison, and British courts picked Joseph Swan. The answer has great implications for the degree of confidence we place in the patent system to pick winners and losers and therefore to structure the proper incentives for technological innovation. The achievement of Lemley’s patent racing model is to weaken the power of the myth that inventions appear out of thin air, and would not have existed but for the contributions of the credited inventor. As the argumentative stance of Howells and Katznelson makes clear, this misperception too easily favors very strong patent rights. But the risk of the patent racing model is that we too strongly buy into its imagery of a fair contest. Patent law on the ground is not this neat and tidy.71

The patent racing model carries an additional risk as well: it tells only part of a story, and leaves out what may be the most important part, from the perspective of innovation. The metaphor of the race best describes the early stages of development of a new technology. In the latter stages of commercialization, improvement, and diffusion of that technology, a different dynamic occurs.72 This dynamic, too, can be understood as a contest or game. But its nature is quite different

71 For a fuller discussion of the “messiness” of real-life patent litigation, see Lea Shaver, Patents, Publicity, and the Myth of Invention (forthcoming 2012).

72 I am indebted to Gaia Bernstein for highlighting important distinction between innovation and diffusion of new technologies. See, e.g., Gaia Bernstein, In the Shadow of Innovation, 31 CARDOZO L. REV. 2257 (2010) (distinguishing the innovation and diffusion stages of a technology’s introduction, and arguing that intellectual property law neglects the latter).
and its implications for innovation not nearly so positive. A look at what happened next in the story of the lightbulb—after the technology was perfected and commercialization had begun—will make this point crystal clear.

III. LEARNING FROM THE LIGHTBULB

A. From Patent Racing to Patent Warfare

The more accurate metaphor is neither a sprint nor a marathon, but the strategic board game *Risk!* In this game, the board resembles a map of the world, with varying territories. In the early stages of the game, players amass tokens representing armies and position them strategically on the board to fortify their positions. Ultimately, the game shifts into attack mode, as players vie to conquer each other’s territories. When a battle is won, the victor not only claims the disputed territory, but also absorbs the losing armies into their own force. Ultimately one party pushes out all the competitors and achieves the goal of the game: world domination.

Similarly, industrial contenders may spend years amassing a patent portfolio and income streams that will eventually fund their litigation war chest. At a certain point, when one party thinks it is the right amount ahead, it begins to close in on its opponents. Both in *Risk!* and in patent warfare, the strategic campaigner should begin by confronting its weakest competitors, where the victories will be easiest. It then amasses strength by absorbing the assets—patent portfolio and market share—of the vanquished foe. Finally the two strongest competitors confront each other, as the Edison and Westinghouse companies faced off in the litigation that reached the Supreme Court in *The Incandescent Lamp Case*.

To paraphrase the classical military theorist Clausewitz: Patent litigation is the continuation of business strategy by other means.


74 I remember playing the game as a child with the winner-absorbs-the-losing-armies provision. But I was unable to find documentation of this rule in the instructions accompanying the 2005 version of the game. My father may have made it up. Whatever the source, this variation offers an even better parallel for patent wars—when decisive patent litigation leads to a takeover of a former competitor, the victorious party expands their own patent portfolio in the process.

75 Carl Philipp Gottfried von Clausewitz was a Prussian General and writer in military theory. His treatise, *On War*, famously claimed: “War is the continuation of politics by other means.”
Patent racing is helpful for understanding how patents impact innovation leading up to the patent filing. But the long-term impact of patent law on industrial competition requires a very different metaphor. Patents acquired in the racing stage become pawns in a battle to achieve market dominance and secure competitive position. Contrary to the metaphor of the race, it is not who is first to the patent office that wins, but who is last left standing at the end of litigation.

In the early days of the lightbulb’s commercial use, patents did not pose a barrier to competition. Harold C. Passer noted that Edison had a significant share of the market early on. This edge was likely due to lead time advantages rather than patents, as litigation had not yet moved far enough. In Passer’s words, “In the beginning, very little attention was paid to patents, and manufacturers could make the entire incandescent system. The dynamo could not be patented, and lamp patents were not respected.” By 1890 Edison’s market share had fallen to less than half. Patent warfare was crucial to reversing that trend and securing Edison’s control of the lightbulb market. Between 1880 and 1895, more than twenty major opinions were issued in U.S. cases disputing Edison’s claims to control of the incandescent lightbulb. The Sawyer-Man infringement suit against Edison alone generated more than 5000 pages of documents, not

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76 PASSER, supra note ___ at 206.
77 Id.
78 Id.
including the patent application and interference stages. Nor was the litigation confined to the American shores. Foreign patents and litigation, especially in Great Britain and Germany, formed an important part of Edison’s transnational litigation strategy.

Among the many patents Edison held on electric ligh bulb technology, the ’898 patent ultimately turned out to be key in U.S. litigation. Issued on January 27, 1880, U.S. Patent No. 223,898 recognized Thomas Alva Edison’s “improvement in electric lamps,” including a claim on “An electric lamp for giving light by incandescence, consisting of a filament of carbon of high resistance, made as described, and secured to metallic wires, as set forth.” The ’898 patent was just one among many patents that Edison sought on the light bulb technology, however, and it was not initially clear that it would prove so central. Many in the industry doubted the validity of its claims. That changed crucially when a Pennsylvania court not only upheld the validity of ’898 patent, but gave it an interpretation so broad as to render virtually every incandescent light bulb infringing. The subsequent litigation produced a stunning consolidation of the previously very competitive American electric industry. After the Supreme Court’s 1895 decision, all US producers either purchased licenses from General Electric or merged with them.

Passer’s economic study documents the transformation of the light bulb market before and after the patent litigation. In the early years of the electrical industry, he writes:

Patents were not significant in either the product or the manufacturing process. In these conditions—a standardized product sold mainly to business firms, relatively free entry, many buyers, and more than fifteen sellers—the market closely approached the economist’s concept of pure competition. The competition was almost entirely in prices, and these were driven down to cost by the additional supply from new firms. But these freely competitive conditions did not prevail for long. The year

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80 BAZERMAN, supra note __ at 239-40.

81 Thomas Alva Edison, Electric Lamp, U.S. Patent No. 223,898 (filed Nov. 11, 1879) (issued Jan. 27, 1880). The patent contains three additional independent claims, which are omitted here for the sake of brevity. Id.

82 BAZERMAN, supra note __, at 89.

83 Id. at 153-54.
1888 marked the end of pure competition in arc carbons, and 1896 [the year after The Incandescent Lamp Patent was decided] saw the termination of pure competition in incandescent lamps.\textsuperscript{84}

By 1897, General Electric was the undisputed leader, and Westinghouse was its only serious rival.\textsuperscript{85} The two companies agreed to a truce in the form of patent cross-licensing and product pricing agreements.\textsuperscript{86} Smaller competitors were invited to join the Incandescent Lamp Manufacturers Association, organized by General Electric. These members agreed to divide up the markets and avoid price competition.\textsuperscript{87} The result was that G.E. sold half of the bulbs in the U.S. market, and the smaller companies divided the other half.\textsuperscript{88} These smaller companies, dependent on G.E. patent licenses for their existence, put no downward pressure on prices and were discouraged from contributing to next-generation innovation to their full potential.\textsuperscript{89} In Bright’s words, “They gave only the appearance of competition.”\textsuperscript{90} Through incorporation, patent litigation, licensing deals and eventually purchases of stock, by 1910 G.E. controlled 97% of the market.\textsuperscript{91} Only then could Edison finally rest, his empire secure.

History remembers Edison as a workshop inventor, a tinkerer—an image established in no small part by Edison’s own efforts. A more

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\textsuperscript{84} Passer, supra note \_, at 350. Passer details forces contributing to the demise of competition including both non-patent and patent factors. Of the latter, he writes: “Patents also influenced competitive conditions. They were a prime cause of the numerous consolidations and mergers which finally resulted in only two full-line producers. Furthermore, patents permitted competition to take place on a system basis instead of with reference to single items of equipment. Manufacturers could refuse to allow the use of particular patented apparatus except as a part of a complete lighting or power system.”

\textsuperscript{85} Bright, supra note 2, at 144.

\textsuperscript{86} Bright, supra note 2, at 12.

\textsuperscript{87} Bright, supra note 2, at 144.

\textsuperscript{88} Id.

\textsuperscript{89} Id. at 457.

\textsuperscript{90} Id.

\textsuperscript{91} Id. at 147-48. An antitrust investigation subsequently found misconduct, but the remedies did not require the company to seriously change its business model. General Electric would continue to dominate the lightbulb market for decades longer.
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accurate historical portrait begins with recognizing Edison as an entrepreneur and empire builder.\footnote{In an unguarded moment, Edison’s voice was captured on his own phonograph in an exchange suggesting Edison saw himself as a “hustler.” Stross tells the story best: One occasion when Edison cast off the expectations of others in his middle age was when he met Henry Stanley, of “Dr. Livingston, I presume” fame, and Stanley’s wife, who had come to visit him at his laboratory in West Orange, N.J. Edison provided a demonstration of the phonograph, which Stanley had never heard before. Stanley asked, in a low voice and slow cadence, “Mr. Edison, if it were possible for you to hear the voice of any man whose name is known in the history of the world, whose voice would you prefer to hear?” “Napoleon’s,” replied Edison without hesitation. “No, no,” Stanley said piously, “I should like to hear the voice of our Savior.” “Well,” explained Edison, “You know, I like a hustler.” Randall Stross, Edison the Inventor: Edison the Showman, N.Y. TIMES, Mar. 11, 2007.} Among his contemporaries working on the lightbulb, Edison had a unique focus on commercialization of the emerging technology, rather than merely securing patents.\footnote{See Harold C. Passer, The Electrical Manufacturers, 1875-1900, at 83 (1953) (“From the economist’s viewpoint, the most significant aspect of Edison’s activities in electric lighting was his concern at every step with economic factors.”). See also Hughes, supra note \textsuperscript{\textendash}, at 29.} Edison was no mere inventor, but a different breed altogether: the inventor-entrepreneur.\footnote{Thomas P. Hughes, Networks of Power: Electrification in Western Society 1880-1930, at 18-22 (1983). Harold C. Passer had earlier written of the engineer-entrepreneur, of which Edison was a leading example. Passer, supra note \textsuperscript{\textendash}, at 356-60. “Edison was an engineer-entrepreneur on a full-time basis when he turned to the electric light. He made the}
intended not merely to license his lightbulb patents, but to commercialize the technology himself; indeed, much of his energies would be consumed in supervising the rollout of his products in the marketplace. In this way, he had much more in common with Steve Jobs or Bill Gates than with the average patent seeker.

As an entrepreneur, Edison knew from past experience with the phonograph that he would have to confront his competition in the marketplace sooner or later, no matter how solid his patent portfolio. Surely he recognized the business advantages that come with being the first to bring a product to market. Edison was not just an experienced inventor and entrepreneur, he was an experienced patent litigator. He appreciated how difficult a task the courts would ultimately face in sorting out the competing lightbulb patent claims, and realized that the party with greater market share and greater income would hold an important strategic advantage in the very expensive process of litigation.

Perhaps Edison ultimately won the patent war over the lightbulb because, uniquely among the parties, he understood true nature of the contest. Throughout the race to the marketplace, each patent filing was merely a mile marker in an ultra-marathon. No one knew at the time of filing which patent claims would turn out to be key, once the market and the litigation began to take shape. This is not to say that patents were unimportant. They were stockpiled for the future, when the competition ultimately shifted from an inventive race to patent war. This battlefield was the true finish line, and the competition here took place as much on the dimensions of litigation and business strategy as on technical merits.

B. The Coming Smartphone Patent War

My model of patent litigation as resembling a game of Risk! was developed solely based on historical evidence. But a similar metaphor has recently been used to describe emerging litigation in the IT industry. According to competition and antitrust law scholar Michael Carrier, “The smartphone industry today is characterized by a thicket of patents and wars based on those patents. Every day brings a new

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move consciously and chose electric lighting as the best of a number of alternatives.” *Id.* at 357.

lawsuit or development between Apple, HTC, Microsoft, Motorola Mobility (MMI), Nokia, and Samsung.\textsuperscript{96} Carrier is neither the first nor the last to refer to the developing pattern of smartphone litigation as patent “warfare.”\textsuperscript{97} Journalists appear to have taken the cue from litigation participants themselves.\textsuperscript{98} This description of litigation as war is revealing. The goal of this patent litigation is not to secure licensing revenues. The goal is to dominate.

Ironically, this new patent war is breaking out in the very sector of the economy where patents have played the smallest role in incentivizing innovation. When the computer industry first emerged in the 1960s, the USPTO refused to consider software patent applications as a matter of policy. Computer companies themselves supported this approach.\textsuperscript{99} The exclusion of software from the categories of patentable technology was never legislatively challenged,

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\textsuperscript{96} Carrier, supra note ___ at 1.
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\textsuperscript{99} Pamela Samuelson, Benson Revisited: The Case Against Patent Protection for Algorithms and Other Computer Program-Related Inventions, 39 EMORY L.J. 1025, 1028 n3 (1990) (describing industry input to a presidential commission in 1966). 1143; See also Id. at 1143 (For an overview of the early legal changes regarding the patentability of software.)
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and was long upheld by the federal courts. In the 1980s and 1990s, copyright was a more important form of IP protection for software than patents. Things changed in the 1990s, notably with the 1994 decision of the Federal Circuit in In re Alappat. Even at this late date, leading software firms opposed the granting of patents in their field. Software engineers themselves – who would be recognized as the inventors on software patents – also overwhelmingly expressed the view that patents were unnecessary and potentially harmful in their field. Nevertheless, the patentability of software has now been accepted in the United States, and the number of software patent applications filed and granted has dramatically increased.

Europe has been even slower than the U.S. to grant patent protection to software, but is moving in the same direction. A sizeable and

100 See, e.g., Gottschalk v. Benson, 409 U.S. 63 (1973) (holding that the software algorithm at issue was not patentable, under the doctrines against patenting of abstract ideas and natural principles; the decision was widely interpreted as severely limiting software patentability).

101 The practical difference between copyright and patent protection is that copyright protects the exact software code against outright duplication, whereas patents can protect the underlying function or concept, even if the would-be imitator writes their own original code. Copyright has been described as offering thinner protection for software, whereas patent protection would be more powerful. Peter S. Menell, Envisioning Copyright Law’s Digital Future, 36 N.Y.L. SCH. L. REV. 63, 65-66 (2003).

102 In re Alappat, 33 F.3d 1526 (Fed. Cir. 1994) (holding that an invention consisting of a novel software algorithm combined with a trivial physical step was eligible for patenting).


106 The European Patent Convention states that methods of “doing business and programs for computers” are not eligible for patent protection. Article 52(3). That prohibition has been significantly modified, however, by more recent legal sources. The European Patent Office
innovative software industry grew up without the incentive of patents; only recently has patent protection expanded to include this field.\textsuperscript{107}

Even under the newer pro-patenting rules, the prevailing dynamic of patenting in the software industry was “defensive” – with companies seeking patent portfolios as leverage to protect themselves against suits by others.\textsuperscript{108} Strong patterns of cross-licensing and a “gentleman’s agreement” kept the major firms from litigating their patents.\textsuperscript{109} In this context, it seemed that the major corporations had chosen to make patenting relatively incidental to their business. Mobile telephony was built upon collaborative industry standards relying on voluntary patent pooling. And the Internet was built upon nonproprietary protocols. These were choices made by industry consensus to limit the power of patent law and thereby avoid its more negative consequences. The peace appeared to be secured by the logic of mutually assured destruction. Alex Blumberg and Laura Sydell summed up the conventional wisdom of industry insiders and followers when they reported in 2011:

All the big tech companies have started amassing troves of software patents – not to build anything, but to defend themselves. If a company’s patent horde is big enough, it can

\begin{quote}


\end{quote}

\textsuperscript{107} See generally James Bessen, supra note ___ (drawing on empirical research to conclude that the spread of software patents has not produced greater innovation, only greater litigation).


essentially say to the world “If you try to sue me with your patents, I’ll sue you with mine.”

It’s mutually assured destruction. But instead of arsenals of nuclear weapons, it’s arsenals of patents.”

It is clear at this point that the truce has broken down. What is less clear is what the consequences of this patent war are likely to be.

The smartphone patent war might be viewed as simply one more episode in the inevitable dynamics of economic uncertainty in a competitive marketplace. We might choose to diversify our personal stock portfolios, but remain confident in the legal system to sort things out properly, and in the markets to rebalance themselves. The lesson of the lightbulb war, however, caution against such confidence and suggest that the public interest requires more urgent action.

The history of the lightbulb suggests that a very likely outcome of today’s patent war is the consolidation of the IT industry into the hands of a single company. On the brink of this battle, the market features players such as Google, Microsoft, IBM, Apple, Motorola, Nokia, HTC, Samsung, and many others. Two decades from now, we should not be surprised if only one of these titans remains standing. This is exactly what happened in the early electrical industry on the heels of patent warfare. If today’s patent war ends similarly, the casualties will again be competition, access to technology, and future innovation.

If history repeats itself in the smartphone patent war, we may once again see the consolidation of a high-technology industry, and the end of meaningful competition. If one company succeeds in controlling the market for smart phones and tablets, the competitive pressure to continually innovate fades. The dominant company not only controls the device itself, moreover, but also has a market dominant position from which to influence the markets for related services: mobile telephony, software, social networking, online advertising, and ebusiness. The only limit on how far such a dominant position could be used to extract rents from and consolidate those related industries would be those limits imposed by antitrust enforcement.

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C. Implications for Innovation

The initial fervor to claim patent rights in the early electrical industry stimulated greater investment in first-generation research. This is consistent with the predictions of Lemley’s patent racing theory. Over the long-term, however, patent protection had a dramatic negative effect on further innovation in the electrical industry. As the industry matured, well-funded companies used patent litigation to target and eliminate their competition. As in the board game *Risk!*, the logical endpoint of such a patent war is dominance of the entire field by a single player. When Edison consolidated control of the lightbulb market under General Electric, next-generation innovation and wider diffusion of the technology slowed. Meanwhile, consumers and smaller businesses literally waited in the dark; another half century would pass before the average American household could afford electric lights.

Regardless of who emerges the winner in *Risk!* the end game is always the same; one party controls the entire board. In the real life version, there may also be a détente where two parties agree to tolerate each other in separate spheres—as General Electric and Westinghouse divided the U.S. and British markets. Either way, however, real competition ends. The implications of patent warfare appear to be overwhelmingly negative for innovation.

The breakout of patent litigation harms innovation in at least two ways. First, litigation is a resource-intensive distraction of capital and human resources, which could otherwise have been invested in improving the product and delivering it more efficiently to consumers. Second, a litigious environment discourages the risk-taking of investing in next-generation innovation, because innovators realize they may legally prevented from producing the technology. Bright notes this dynamic in the early electrical industry: as the lightbulb litigation heated up, technological innovation dimmed.111 Industry analysts should be alert for signs of a similar slow-down in the smartphone industry in the coming years, regardless of how the litigation is ultimately resolved.

111 BRIGHT, supra note __, at 138 (“The early technical leadership fo the Edison Electric Light Company diminished as Edison himself moved on to other fields of experimentation and the company devoted itself increasingly to promotion, production, and litigation. The lengthy and expensive patent struggle in the lamp industry from 1885 to 1894 was a serious damper on progress in lamp design, although process improvement continued.”)
If patent warfare results in its logical conclusion—the consolidation of control over an entire industrial sector—the consequences for next-generation innovation go even further. This was the case in the aftermath of the lightbulb litigation. General Electric was able to prevent any other lightbulb manufacturer from exerting downward pressure on prices; the only real competitive pressure came from further advances in the substitute technology of gas lighting.\footnote{Id. at 457.} This is not to say that lightbulb innovation ground to a halt. General Electric still had profit-based incentives to cut its own production costs through more efficient technologies.\footnote{BRIGHT, supra note __, at 455 (“The industry leader has possessed immense ability to achieve technological advances, arising out of its direct control of two-thirds of the lamp market, its high profits, its Schenectady research laboratory, the broad strength of the entire company, and its eagerness to attract able men. General Electric has also had strong incentives to make improvements in lamp design and production methods. The importance of patents in maintaining the license and quota system, the need for cost reductions to match price cuts and maintain profits, and the need for new designs to retain its market leadership and reputation, all have encouraged continuous research and development.”)} But it no longer risked being overtaken by a competitor if it lagged behind in the innovative endeavor.

The long-term damage to next-generation innovation is not limited to the twenty years of the modern patent term. By the time first-generation patents become obsolete, newer patents already exist to take their place. When Edison’s patents expired, General Electric was able to use newer ones to continue its control over the lightbulb market.\footnote{Id. at 458.} The result in the case of the lightbulb was that General Electric would control the electric lighting industry for many decades longer. Even as Arthur A. Bright published his thesis on the Electric-Lamp Industry in 1949, General Electric’s monopolization of the electric lighting industry remained a problem for competition and next-generation innovation.

These public policy concerns—competition and innovation—may sound vague and abstract. But their concrete implications were visible to every American. As competition slowed and prices remained high, millions of Americans literally waited in the dark. Electric light took another half-century after Thomas Edison filed his first patents to find its way into the average American home. The slow improvement of incandescent lamp technology is thus a very unfortunate outcome from the perspective of consumer interests. But consider also the fact...
that electric lighting proved to be the central driver for electrification in general, and all the myriad ways in which access to electricity has made our lives richer and our economy more productive. Had patent warfare not held back the early electrical industry, how much further ahead would our entire economy be today?

This anticompetitive endgame is my central concern with the use of patent racing theory as a new justification for patent protection. The racing metaphor paints a picture of objectivity and fair competition. In the case of the lightbulb, however, the race was merely a prelude to the war. Patents almost certainly add fervor to inventive races at a certain stage of research and development. But at a later stage, patents also become weapons that competitors use to threaten and dominate their competition, long before the public policy goal of wide diffusion of the new technology has been fully attained. This has the perverse effect of ultimately limiting next-generation innovation. In the end, enthusiasm for the competitive advantages of racing may be an argument against patent protection, rather than an argument in its favor.

The story of the lightbulb thus turns out to be a cautionary tale against reliance on the innovation assumption. The downsides of patent protection for technological innovation are systematically underappreciated. Partly this has to do with our methodology of study. Empirical study of recent fields of technology is best at highlighting the initial, short-term impacts of patent protection. These include assistance in recruiting capital to fund research and product development, and in outsourcing production chains – both of which are positives for innovation. Only historical study can reveal the longer-term impacts that patent litigation produces on an industry. These are systematically more negative, as patents become weapons in attempts to monopolize a field and halt further competition. Greater historical research is needed to further clarify the long-term impacts of patent wars, determine whether they are typical or exceptional features of technological innovation in the shadow of patent law, and identify strategies that have worked in the past to mitigate the damage patent warfare can do to next-generation innovation.

CONCLUSION

Although patent law is founded on the assumption that patent protection encourages innovation, there is little empirical support for this claim. This Article has argued that historical case studies can offer a stronger empirical basis for patent scholarship, by illuminating the true impact of patent law on innovation over the longer term. The
present case study demonstrates this potential, both by refining existing theory on patent racing, and by offering a new model of patent warfare. Patent warfare transformed the electrical industry at the close of the nineteenth century, and now threatens to transform the IT industry in our own time. The case study of the lightbulb shows that the stakes are high indeed. It is time to move replace the innovation assumption with the innovation hypothesis, and put patent law upon a more solid empirical foundation.