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PATENT RIGHTS IN A CLIMATE OF INTELLECTUAL PROPERTY RIGHTS SKEPTICISM

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I. INTRODUCTION

A movement is underway to dilute U.S. patents, which have recently been the object of unprecedented criticism. U.S. policymakers lack clear guideposts for evaluating this criticism. Further, some emerging economies are at a crossroads in deciding how to treat proprietary technology, and they look at this U.S. debate through the prism of their own history and economic pressures. As a Commissioner on the Federal Trade Commission ("FTC"), I have consistently advocated for protecting intellectual property rights ("IP rights"), both domestically and abroad. That view is not an outlier, but neither does it enjoy unanimous support. A challenge to sorting out the conflicting arguments is that commentators on both sides often couch their views

* Commissioner, Federal Trade Commission. The views expressed in this Article are solely those of the author and do not necessarily reflect the views of the Federal Trade Commission or any other Commissioner. The author would like to thank Alan Devlin for his extensive research efforts and thoughtful analysis, which were invaluable to this paper.

in conclusory terms, reflecting strongly held beliefs about how patents either solve public-goods problems or inhibit technological progress by inventors who have reasons beyond IPRs to invest in research and development ("R&D").

In order to provide a clearer policy path through this thicket, this Article explores the empirical and theoretical literature on the relationship between patents and innovation. In crafting the most beneficial patent policy, we should not overlook or minimize the strong theoretical and evidentiary justifications for property rights in technology, although this does not mean that granting ever-stronger patent protection will inevitably lead to ever-greater innovation. Limited patent reform may also be appropriate to address identified problems such as insufficient quality control, the broad scope of certain method patents, and inadequate disclosure. Despite this fine-tuning, the United States should continue to lead the way in protecting the rights of deserving inventors and in encouraging other countries to do the same. This Article thus builds upon my prior enforcement decisions and speeches, which have advocated for the rights of legitimate inventors to monetize their innovations, cautioned against undermining IP rights, and sought a targeted response to problems with the contemporary patent system.[1]

To evaluate today's patent regime responsibly, policymakers should start with evidence about patents' economic effects. Surprisingly, there is no broad consensus on how IP rights affect technological advance, despite the prominent role of patents in the economy. One common justification for the patent system is to protect inventors against third parties that would appropriate their costly and hard-won insights; certainly there are settings where innovation is both R&D intensive and vulnerable to copying, such as with respect to pharmaceutical innovation.[2] However, the larger world of innovation does not always align with this narrative. Indeed, most patentees who sue for infringement do not even allege copying.[3] Thus, the reality can be

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1. *See, e.g.*, Maureen K. Ohlhausen & Dan Schneider, *Intellectual Property and the National Security Issue*, WASH. TIMES (Dec. 1, 2015), http://www.washingtontimes.com/news/2015/dec/1/maureen-ohlhausen-dan-schneider-intellectual-prope/ [https://perma.cc/TSU8-PJ67]; Maureen K. Ohlhausen & Joshua D. Wright, *Reply Submission on the Public Interest — In re Certain 3G Mobile Handsets & Components Thereof*, U.S. Int'l Trade Comm'n (July 20, 2015) [hereinafter *Reply Sumission*]; Maureen K. Ohlhausen, Commissioner, Fed. Trade Comm'n, Speech to the China Intellectual Property Law Association's IP and Antitrust Forum: Antitrust Oversight of Standard-Essential Patents: The Role of Injunctions (Sept. 12, 2015) [hereinafter Antitrust Oversight of Standard-Essential Patents]; Maureen K. Ohlhausen, Commissioner, Fed. Trade Comm'n, Remarks Before the Second Annual GCR Live Conference: Antitrust Enforcement in China — What Next? (Sept. 16, 2014).

2. *See, e.g.*, Dan L. Burk & Mark A. Lemley, *Policy Levers in Patent Law*, 89 VA. L. REV. 1575, 1581–82, 1590, 1616–17 (2003).

3. Christopher A. Cotropia & Mark A. Lemley, *Copying in Patent Law*, 87 N.C. L. REV. 1421, 1444–45 (2009). In patent law, unlike, for example, in copyright law, infringement

more complicated than the core theory might suggest, increasing the need for actual evidence.

Weighing the pros and cons of the patent regime from an evidentiary perspective, however, is challenging. Consider the potential benefits of the patent system: allowing inventors to capture more of the social value of their discoveries induces them to devote more capital to R&D than would otherwise be the case. That tendency applies not only to invention, but also to commercialization.[4] The result — so the theory goes — is more eclectic and qualitatively superior innovation. But testing for that outcome is not straightforward.

Patents may yield benefits, but some of those benefits extend into the future, are difficult to confirm, and are even harder to quantify. By contrast, patents impose obvious costs in the present. First, the cost and prevalence of patent litigation have increased over time, cutting into accused infringers' and patentees' bottom lines.[5] Second, the best patents may confer economic power, raising the possibility that consumers must pay monopoly prices or forego products or services that they could have afforded under competition.[6] This concern is not abstract. Life-saving drugs, for instance, can be expensive prior to generic entry, impacting healthcare costs in general and pricing some patients out of the market.[7] Third, broad patents can encumber follow-on innovation in high-transaction-cost environments where improvers cannot easily bargain with the patentee.[8] Fourth, technology users face a near-inevitable risk of infringement due to the number of patents and the difficulty of achieving a guaranteed clearing position ex

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does not require copying. Rather, an infringer need only make, use, offer to sell, or sell any patented invention without permission. 35 U.S.C. § 271(a) (2012).

4. *See* F. Scott Kieff, *Property Rights and Property Rules for Commercializing Inventions*, 85 MINN. L. REV. 697, 707–08 (2001).

5. *See, e.g.*, Ian D. McClure, *Accountability in the Patent Market Part II: Should Public Corporations Disclose More to Shareholders?*, 26 FORDHAM INTELL. PROP. MEDIA & ENT. L.J. 417, 421 (2016). In the last two years, however, the total number of U.S. patent infringement cases has declined. *See* PWC, 2016 PATENT LITIGATION STUDY: ARE WE AT AN INFLECTION POINT? (May 2016), http://www.pwc.com/us/en/forensic-services/publications/assets/2016-pwc-patent-litigation-study.pdf [https://perma.cc/5ZCH-YJZ5].

6. *See, e.g.*, Benjamin N. Roin, *Intellectual Property Versus Prizes: Reframing the Debate*, 81 U. CHI. L. REV. 999, 1001 (2014).

7. *See, e.g.*, FED. TRADE COMM'N, AUTHORIZED GENERIC DRUGS: SHORT-TERM EFFECTS AND LONG-TERM IMPACTS, ii–iii (2011). *See generally* Luke M. Olson & Brett W. Wendling, *The Effect of Generic Drug Competition on Generic Drug Prices During the Hatch-Waxman 180-Day Exclusivity Period* (Fed. Trade Comm'n. Bureau of Econ., Working Paper No. 317, 2013) https://www.ftc.gov/sites/default/files/documents/reports/estimating-effect-entry-generic-drug-prices-using-hatch-waxman-exclusivity/wp317.pdf [https://perma.cc/E4CV-ELXJ].

8. *See* Janet Freilich, *The Uninformed Topography of Patent Scope*, 19 STAN. TECH. L. REV. 150, 152–53 (2015). *See generally* Robert P. Merges & Richard R. Nelson, *On the Complex Economics of Patent Scope*, 90 COLUM. L. REV. 839 (1990).

ante.[9] Such difficulties can hinder ex ante technology transfer, making patent licensing less efficient.[10]

Given these costs, it is no surprise that some commentators ask whether the patent system can justify its price. Some observers assert that the presumption that patents spur more invention is unsupported by evidence.[11] Patent skeptics argue that innovators will not only continue to invent without patents, but will do so at a higher rate and at a lower cost to society.[12] Those claims warrant serious consideration.

This Article defends robust patent rights based on evidence about the relationship between patents and innovation. It is true that it is not always possible to identify when patents are a but-for cause of innovation, and the patent system has flaws and is subject to some abuse.[13] Nevertheless, there is ample evidence that patents serve a materially valuable role in promoting innovation in at least some settings.[14] Given the rich innovation in markets where claimed patent-related problems are most prevalent — as well as patents' longstanding role within America's larger innovation platform — the cautious, informed, and in my view, correct response is incremental, targeted adjustment. Patents should remain a central feature of U.S. technology policy.

This topic matters not just in the U.S. but also globally, and what we say and do here to our patent system reverberates around the world. That is especially so in places that lack a strong history of protecting IP rights; few developing countries actively combat piracy, for instance.[15] Some observers assert that influential jurisdictions appear to use their antitrust powers not to protect competition, but to regulate the price of patent rights.[16] Such critics point to Qualcomm's agreement to pay $975 million and to lower its royalty rates by more than a

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9. *See, e.g.*, Christina Mulligan & Timothy B. Lee, *Scaling the Patent System*, 68 N.Y.U. ANN. SURV. AM. L. 289, 304–05 (2012); Mark A. Lemley, *Ignoring Patents*, 2008 MICH. ST. L. REV. 19, 21–22 (2008).

10. *See generally* FED. TRADE COMM'N, THE EVOLVING IP MARKETPLACE: ALIGNING PATENT NOTICE AND REMEDIES WITH COMPETITION (2011) (noting the proliferation of ex post patent licensing, in lieu of ex ante technology transfer, and explaining the normative implications of that dynamic).

11. *See infra* Part II.A.

12. *See infra* Part II.A.

13. *See, e.g.*, FED. TRADE COMM'N, PATENT ASSERTION ENTITY ACTIVITY: AN FTC STUDY (2016) [hereinafter PAE STUDY] (observing that Litigation PAEs may be engaging in nuisance litigation); FED. TRADE COMM'N, THE EVOLVING IP MARKETPLACE: ALIGNING PATENT NOTICE AND REMEDIES WITH COMPETITION (2011) [hereinafter PATENT NOTICE AND REMEDIES] (explaining the complicated welfare effects of widespread ex post patent licensing, as distinct from unambiguously efficient ex ante technology transfer).

14. *See infra* Part III.B.

15. *See, e.g.*, OFFICE OF THE U.S. TRADE REPRESENTATIVE, 2016 SPECIAL 301 REPORT (2016), https://ustr.gov/sites/default/files/USTR-2016-Special-301-Report.pdf [Add perma].

16. *See, e.g.*, Shubha Ghosh & D. Daniel Sokol, *FRAND in India* 5 (Univ. of Wis., Legal Studies Research Paper No. 1374, 2016) http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2718256&download=yes [https://perma.cc/QWU5-K5XM].

third to Chinese companies to end China's antitrust investigation,[17] as well as to the Korean Fair Trade Commission ("KFTC") action to fine Qualcomm and force it to change its licensing practices.[18]

Other international events also point to diluted IP rights. In August 2015, China adopted an essential-facilities doctrine that may require the compulsory licensing of IP rights by firms considered dominant.[19] The Japanese Fair Trade Commission has promulgated rules prohibiting owners of standard-essential patents ("SEPs") from seeking injunctive relief, "even if the acts do not substantially restrict competition."[20] The Director of the KFTC has opined that "the exercise of IP rights has the potential to become a monster" and that IP rights "can undermine technological development."[21] And the Competition Commission of India has found that charging unreasonably high royalties, or basing royalty calculations on final-product sales, on FRAND-encumbered SEPs abuses a dominant position.[22]

A recalibration of patent rights is also underway in America. Although it has reached some pro-patentee decisions,[23] the U.S. Supreme Court has recently diluted patent rights in other cases. The Court has limited the sphere of patentable subject matter,[24] made it difficult for

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17. *See, e.g.*, U.S. CHAMBER OF COMMERCE, COMPETING INTERESTS IN CHINA'S COMPETITION LAW ENFORCEMENT: CHINA'S ANTI-MONOPOLY LAW APPLICATION AND THE ROLE OF INDUSTRIAL POLICY 62–66 (2014) https://www.uschamber.com/sites/default/files/aml_final_090814_final_locked.pdf [https://perma.cc/93N6-GBK8].

18. Mark Briggs, *KFTC Recommends Fines Against Qualcomm*, GLOBAL COMPETITION REVIEW (Nov. 18, 2015) http://globalcompetitionreview.com/news/article/39853/kftc-recommends-fines-against-qualcomm [https://perma.cc/9PAQ-GHLY]; Erik Telford, *Is South Korea Practicing Protectionism?*, THE HILL (Sept. 18, 2015) http://thehill.com/blogs/congress-blog/foreign-policy/254045-is-south-korea-practicing-protectionism [https://perma.cc/2LJP-CZRV].

19. STATE ADMIN. OF INDUS. & COMMERCE, PROVISIONS ON THE PROHIBITION OF THE ABUSE OF INTELLECTUAL PROPERTY RIGHTS TO ELIMINATE OR RESTRAIN COMPETITION, Art. 7 (2015), http://www.kangxin.com/en/index.php?optionid=927&auto_id=726 [https://perma.cc/C8DA-GHMD].

20. JAPAN FAIR TRADE COMM'N, GUIDELINES FOR THE USE OF INTELLECTUAL PROPERTY UNDER THE ANTIMONOPOLY ACT Part 4(2)(iv) (2015); *see also* Lisa Kimmel, *Injunctive Relief for Infringement of FRAND-Assured Standard-Essential Patents: Japan and Canada Propose New Antitrust Guidance*, CPI ANTITRUST CHRON., Oct. 2015, https://www.competitionpolicyinternational.com/assets/Uploads/KimmelOct-151.pdf [https://perma.cc/Z6PS-XL2Y].

21. *See* Pallavi Guniganti, *KFTC Official: IP Rights Could be "a Monster"*, GLOBAL COMPETITION REV. (May 19, 2015) (quoting Seong-guen Kim, Director, International Cooperation Division, KFTC).

22. *See, e.g.*, Ghosh & Sokol, *supra* note 16, at 5.

23. Commil USA LLC v. Cisco Sys. Inc., 135 S. Ct. 1920, 1929 (2015) (holding that an alleged infringer's good-faith belief in a patent's invalidity is not a defense to induced infringement); Microsoft Corp. v. i4i Ltd. P'ship, 131 S. Ct. 2238, 2246 (2011) (holding that an accused infringer must prove patent invalidity with clear and convincing evidence); *see also* Teva Pharm. USA v. Sandoz, Inc., 135 S. Ct. 831, 836 (2015) (holding that Federal Circuit must apply deferential clear error standard to district court's claim construction).

24. *See* Alice Corp. Pty. Ltd. v. CLS Bank Int'l, 134 S. Ct. 2347, 2357 (2014) (denying protection to "generic computer implementation" of otherwise abstract ideas); Ass'n for Molecular Pathology v. Myriad Genetics, Inc., 133 S. Ct. 2107, 2120 (2013) (denying pro-

patentees to obtain injunctions,[25] reduced a defendant's burden to show obviousness,[26] enhanced the definiteness requirement,[27] made it easier for district courts to award costs and fees to an accused infringer who prevails,[28] and limited the scope of induced infringement.[29] Following the 2011 America Invents Act,[30] which introduced post-grant and inter partes review, the Patent Trial and Appeals Board ("PTAB") has invalidated patents on a large scale.[31]

Many of those actions sensibly bolster the patent system. Nevertheless, the collective legal environment has been hostile to U.S. patent owners. Those developments take place alongside an academic discourse overflowing with criticism of today's patent regime. Some commentators argue that patents have become divorced from their utilitarian function, acting to brake rather than to drive scientific advance.[32] Reflecting the mantra that "information wants to be free," some such critics argue that there is little or no evidence that patents promote innovation.[33] The ensuing calls for policy change have seldom been modest: some even call for outright patent abolition.[34] Others defend property rights in technology, even if the system — as with any legal regime — does not operate perfectly in all cases.[35]

Some commentators suggest that many of those who variously defend or vilify the patent system rely simply on faith that IP rights enhance or hinder technological progress.[36] Blind faith in either direc-

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tection for isolation of naturally occurring DNA sequences); Mayo Collaborative Servs. v. Prometheus Labs., Inc., 132 S. Ct. 1289, 1294 (2012) (denying protection to processes that identify natural correlations and add only "well-understood, routine, conventional activity previously engaged in by researchers in the field"); Bilski v. Kappos, 561 U.S. 593, 609 (2010) (denying protection to concept of hedging risk and its application to energy markets).

25. *See* eBay Inc. v. MercExchange, LLC, 547 U.S. 388, 392–93 (2006).

26. *See* KSR Int'l Co. v. Teleflex, Inc., 550 U.S. 398, 415 (2007).

27. *See* Nautilus Inc. v. Biosig Instruments Inc., 134 S. Ct. 2120, 2129–30 (2014).

28. *See generally* Octane Fitness, LLC v. ICON Health & Fitness, Inc., 134 S. Ct. 1749 (2014); *see also* Highmark Inc. v. Allcare Health Mgmt. Sys. Inc., 134 S. Ct. 1744, 1748 (2014).

29. *See generally* Limelight Networks Inc. v. Akamai Techs. Inc., 134 S. Ct. 2111 (2014).

30. Leahy-Smith America Invents Act, Pub. L. No. 112-29, 125 Stat. 284 (2011) (codified as amended throughout Title 35).

31. *See* Brian J. Love & Shawn Ambwani, *Inter Partes Review: An Early Look at the Numbers*, 89 U. CHI. L. REV. DIALOGUE 93 (2014).

32. *See* MICHELE BOLDRIN & DAVID K. LEVINE, AGAINST INTELLECTUAL MONOPOLY (2010).

33. *See* Part II.A. *infra*.

34. *See* BOLDRIN & LEVINE, *supra* note 32; ADAM B. JAFFE & JOSH LERNER, INNOVATION AND ITS DISCONTENTS: HOW OUR BROKEN PATENT SYSTEM IS ENDANGERING INNOVATION AND PROGRESS, AND WHAT TO DO ABOUT IT (2007).

35. *See, e.g.*, Adam Mossoff, *Policy Debates on Patents Should Focus on Facts, Not Rhetoric*, FORBES (Dec. 18, 2012), http://www.forbes.com/sites/realspin/2012/12/18/policy-debates-on-patents-should-focus-on-facts-not-rhetoric/#3e59a80216e5.

36. *See, e.g.*, Mark A. Lemley, *Faith-Based Intellectual Property*, 62 UCLA L. REV. 1328 (2015).

tion is an irresponsible foundation for action by policymakers. In an effort to provide a firmer foundation for any policy in the IP space, this Article explores the empirical literature governing the relationship between patents, R&D, and economic growth. The goal is not comprehensively to review the econometric literature on the subject. Rather, it is to distill the literature's principal teachings and to use the information — albeit incomplete and resistant to broad prescriptions — to help formulate responsible policy positions. Policymakers who wish to promote consumers' interests must not avoid difficult questions but must seek to answer them as best they can with the tools at hand. Invariably, error analysis comes into play. Much good-faith disagreement arises because of imperfect information, a need to resort to intuition in teasing larger conclusions out of ambiguous data, and differing appetites for risk in advocating departures from the status quo.

My view — in light of the relevant theory, econometric evidence, and the U.S. experience with a successful innovation policy of which patents form a central part — is that strong patent rights should remain at the heart of the U.S. industrial policy. That does not mean uncritical embrace of ever-broader patents in all industries, however. The need to scrutinize the novelty, nonobviousness, and utility of claimed inventions, to adjust disclosure requirements, and to calibrate appropriate compensation should take into account the incentives that drive R&D in various settings. Nevertheless, this Article's bottom line is that patents promote technical advance — albeit to varying degrees — across industries. I worry that today's calls for diluted patent rights often go beyond incremental adjustment and threaten to weaken patents systemically, which could compromise R&D investment. Further, it helps to undermine overseas protection of U.S. technologies. Developing countries watch American innovation policy closely and U.S. restrictions on patent rights may spur other nations to limit inventors' rights in a more radical fashion.[37]

Part II recounts the fierce criticism of the patent system that has emerged from some sources and then explains why those critiques arose and how they coincide with new global limits on patent rights. Part III explains the theory underlying the patent system. It explores the economic literature that provides insights on when patents are likely to promote or hinder innovation. Having established that baseline, Part IV swivels to the heart of this Article: an examination of the empirical literature that has studied the relationship between patents and technological progress. Part IV addresses criticisms that the patent system does not promote R&D. A brief conclusion follows,

37. Antitrust Oversight of Standard-Essential Patents, *supra* note 1.

which captures the essence of my argument for a strong patent system.

II. THE PATENT SYSTEM UNDER FIRE

The cornerstone of American innovation policy, patents allow inventors to prevent others from copying their hard-earned creations, encourage firms to invest in commercializing technologies, prompt technology transfer, disclose cutting-edge insights to those skilled in the art, and reflect the U.S. tradition of honoring property rights. Why, then, are they so controversial today? This Part provides an overview of the most notable contemporary criticism of the patent regime, and then pivots to the reasons why patents draw greater controversy in the U.S. today than they have historically.

A. The Patent System Is Presently the Object of Unprecedented Criticism

Respected economists Michele Boldrin and David Levine find "no evidence that intellectual monopoly achieves the desired purpose of increasing innovation," describe IP rights as an "unnecessary evil," and call for the patent system's abolition.[38] Economist Adam Jaffe and Harvard Business School professor Josh Lerner call the patent system "broken."[39] Law professors Michael Meurer and James Bessen think it "unlikely that patents today are an effective policy instrument to encourage innovation overall."[40] As for encouraging ideas, the Economist wrote that "[t]oday's patent systems are a rotten way of rewarding them."[41] Indeed, the magazine appeared to embrace the notion that "society as a whole might even be better off with no patents than with the mess that is today's system."[42] In law professor Thomas Cheng's view, theory and empirical studies "firmly refute[] the notion that patent protection is necessary for securing innovation."[43] Richard Stallman argues that "patent law should be abol-

38. BOLDRIN & LEVINE, *supra* note 32, at 7, 11; *see also* Michele Boldrin & David K. Levine, *The Case Against Patents*, 27 J. ECON. PERSP. 3, 3–4 (2013).

39. *See generally* JAFFE & LERNER, *supra* note 34.

40. JAMES BESSEN & MICHAEL J. MEURER, PATENT FAILURE: HOW JUDGES, BUREAUCRATS, AND LAWYERS PUT INNOVATORS AT RISK 216 (2008).

41. *Time to Fix Patents*, THE ECONOMIST (Aug. 8, 2015), http://www.economist.com/news/leaders/21660522-ideas-fuel-economy-todays-patent-systems-are-rotten-way-rewarding-them-time-fix [https://perma.cc/QRE7-RWSE].

42. *A Question of Utility*, THE ECONOMIST (Aug. 8, 2015), http://www.economist.com/node/21660559 [https://perma.cc/7VE7-7A5F].

43. Thomas K. Cheng, *A Developmental Approach to the Patent-Antitrust Intersection*, 33 NW. J. INT'L L. & BUS. 1, 46 (2012).

ished."[44] The Electronic Frontier Foundation's view is that the "patent system is broken" and "it's time to start over."[45]

The chorus of criticism goes on. Attorney William Hubbard argues that "patent protection in the United States should be weakened."[46] The Hon. Richard A. Posner sees "serious problems with our patent system."[47] A leading authority on patent law, Mark Lemley, has proclaimed the existence of a "patent crisis."[48] A renowned economist, Carl Shapiro, believes that the "patent system . . . provides excessive rewards to patent holders . . . reduc[ing] economic efficiency by discouraging innovation."[49] Even Google, which secured more than 2,500 patents in 2014[50], has sometimes poured cold water on the importance of IP rights. Its general counsel, Kent Walker, has opined that a "patent isn't innovation. It's the right to block someone else from innovating" and that "patents are not encouraging innovation."[51] Although outright elimination of the patent regime is an outlier view, many commentators believe that society ought to jettison patents in particular fields of invention such as computer software, business

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44. Richard Stallman, *Patent Law Is, at Best, Not Worth Keeping*, 45 LOY. U. CHI. L.J. 389, 389 (2013).

45. *Patent Fail: In Defense of Innovation*, ELECTRONIC FRONTIER FOUNDATION, https://www.eff.org/patent [https://perma.cc/77YV-Z3TK].

46. William Hubbard, *The Competitive Advantage of Weak Patents*, 54 B.C. L. REV. 1909, 1913 (2013).

47. Richard A. Posner, *Why There Are Too Many Patents in America*, ATLANTIC (July 12, 2012), http://www.theatlantic.com/business/archive/2012/07/why-there-are-too-many-patents-in-america/259725/ [https://perma.cc/A4T9-C3MH].

48. *See* DAN L. BURK & MARK A. LEMLEY, THE PATENT CRISIS AND HOW THE COURTS CAN SOLVE IT 167–70 (2009).

49. Carl Shapiro, *Patent Reform: Aligning Reward and Contribution*, 8 INNOV. POL'Y & ECON. 111, 112 (2007).

50. IFI Claims Patents Services, *IFI CLAIMS 2014 Top 50 US Patent Assignees*, (updated Jan. 29, 2015), http://www.ificlaims.com/index.php?page=misc_top_50_2014; Intellectual Property Owners Association, *Top 300 Organizations Granted U.S. Patents in 201*4 (June 15, 2015), http://www.ipo.org/wp-content/uploads/2015/06/2014-Top-300.pdf.

51. M.G. Siegler, *Google on the Nortel Loss, Patents as Government-Granted Monopolies, and Plates of Spaghetti*, TECHCRUNCH (July 25, 2011), http://techcrunch.com/2011/07/25/google-patent-fight/ [http://perma.cc/C9ES-KQ73]. Still, Google's head of patent transactions has explained that, "[a]t Google, we appreciate that patents play an important role in fostering innovations in many different ways." Deloitte, *Patent Reform and CFO Considerations: Views from Google, Intellectual Ventures, ManyWorlds and RPX*, WALL ST. J. (Nov. 9, 2015, 12:01 AM), http://deloitte.wsj.com/cfo/2015/11/09/patent-reform-and-cfo-considerations-views-from-google-intellectual-ventures-manyworlds-and-rpx/ [http://perma.cc/ M4QU-85UH].

methods, and genetics.[52] Even some who have defended the status quo have done so reluctantly.[53]

Whether these claims are justified or not, it is remarkable that the stalwart of U.S. innovation policy has become so controversial. The proceeding Section explores events over the last two decades that have led to mounting criticism of the U.S. patent regime, and then explains why it is so important that we resolve questions surrounding patents' contribution to innovation policy.

B. The Road to Controversy: How Changing Technologies Distress a One-Size-Fits-All Patent System

Patents attract controversy by their nature. A patent's definitive quality — the right to exclude — means that some firms wishing to market a technological good or to employ a useful process cannot do so. Patent rights deny consumers lower prices and a wider choice among sellers in the short term in the hope of achieving greater long-term gains. Those experiencing the immediate costs are prone to complain, but it is important that policymakers not uncritically equate the protests of these aggrieved stakeholders with the public interest.

It is no surprise that inventors of breakthrough technologies have reaped great rewards historically, in the process suppressing near-term competition. In the 1910s, Glenn Curtiss and other innovators in the aviation space sought to develop alternative aeronautic technologies, but faced blocking patents held by the Wright Brothers.[54] So, too, Edison's General Electric Company excluded all competition in incandescent lamps in the late 1800s.[55] In some academics' estimation, such "pioneer patents" did not produce smooth licensing and coordination.[56] Rather, they contend, such broad patents gave rise to litigation and suppressed third-party improvements.[57] History is replete with examples of companies that achieved great economic power in part through patent holdings, from AT&T in the telecommunications space to Kobe in oil drilling, both of which ultimately fell afoul of antitrust law.[58]

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52. *See* Pamela Samuelson, Benson *Revisited: The Case Against Patent Protection for Algorithms and Other Computer Program-Related Inventions*, 39 EMORY L.J. 1025, 1025–26 (1990); Joshua D. Sarnoff, *Patent-Eligible Inventions After Bilski: History and Theory*, 63 HASTINGS L.J. 53, 94–101 (2011).

53. *See, e.g.*, Brian Peckham, *Should the U.S. Patent Laws Be Abolished?*, 11 J. CONTEMP. L. 389, 421 (1985).

54. *See* Merges & Nelson, *supra* note 8, at 888–91.

55. *See id.* at 885–88.

56. *See generally id.*

57. *Id*.

58. *See* MCI Commc'ns Corp. v. AT&T, 708 F.2d 1081, 1092–93 (7th Cir. 1983), *cert. denied*, 464 U.S. 891 (1983); Kobe, Inc. v. Dempsey Pump Co., 198 F.2d 416, 423–24 (10th Cir. 1952), *cert. denied*, 344 U.S. 837 (1952).

Even if groundbreaking inventors encumbered cumulative innovation in such ways, however, few question those innovators' claim to a share of the social value flowing from their insights. Generally, the patent-policy debate accompanying revolutionary advances over the prior art goes to optimal breadth of the exclusive right — not to whether society should grant any such right at all. Thus, despite occasional controversy, patents have enjoyed an illustrious reputation. Associated with famous inventors like Thomas Edison, Alexander Graham Bell, and Samuel Morse, patents symbolize ingenuity and innovative brilliance. It is no surprise that they have been so central to the U.S. legal tradition given their explicit constitutional recognition.[59]

The maelstrom of controversy surrounding the U.S. patent system today, however, is unprecedented. One cause is that the patent system emerged in a time when mechanical inventions and manufacturing processes accounted for the lion's share of innovation.[60] Indeed, at the turn of the twentieth century, "if you put technology in a bag and shook it, it would make some noise."[61] Today, the reality is different. Advances in computing, microelectronics, nanotechnology, and beyond have given rise to increasingly sophisticated consumer products that combine a dazzling array of discrete technologies. RPX has estimated, for instance, that a quarter of a million active patents may read on smartphone products.[62] Even one semiconductor chip may implicate thousands of patents.[63]

Standing alone, the fact that many separate IP rights relate to a single device does not mean that patents encumber technical advance, however. Each act of invention matters and should be encouraged. Patents can create incentives necessary to engage in further R&D, and those incentives are no less important because the invention is part — rather than the entirety — of an end product. Still, problems can emerge when the technology search and licensing environment is subject to significant transaction costs. Were bargaining free, inventors and users of the technologies would easily find each other, negotiate royalties tied to competitive alternatives, and enable the seamless, downstream flow of proprietary technology.

In practice, however, transaction costs can rise steeply in an environment where myriad patents relate to a single device, especially if

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59. U.S. CONST. art. I, § 8, cl. 8.

60. *See, e.g.*, Sean B. Seymore, *Atypical Inventions*, 86 NOTRE DAME L. REV. 2057, 2064 (2011).

61. Robert P. Merges, *As Many as Six Impossible Patents Before Breakfast: Property Rights for Business Concepts and Patent System Reform*, 14 BERKELEY TECH. L.J. 577, 585 (1999).

62. RPX Corp., Registration Statement (Form S-1), 59 (Sept. 2, 2011).

63. Deborah Platt Majoras, *A Government Perspective on IP and Antitrust Law*, 38 RUTGERS L.J. 493, 497 (2007).

ownership of the relevant patents is atomized. In that case, securing a clearing position would require identifying and successfully negotiating with many different parties. The fact that some patents employ vague claim language and provide only modest disclosure compounds the difficulty.[64] That phenomenon is especially likely to arise with respect to patents directed at business methods and software-implemented processes.[65] Not all such patents are ambiguous, of course, but a material proportion of them have that characteristic. Many attribute this problem to the Federal Circuit's 1998 decision in *State Street Bank*, which held that methods are patentable if they achieve a useful, concrete, or tangible result.[66] That decision paved the way for the USPTO to issue thousands of business method patents, often without the benefit of a rich prior art with which to make informed nonobviousness and novelty decisions.[67]

The result today is that, in industries such as information technology and consumer electronics, there is a disconnect between invention and commercialization. Fearing inadvertent or willful infringement, and perhaps due to an inability to secure at reasonable cost a guaranteed clearing position ex ante, many technology implementers instruct their engineers simply to ignore patents and to develop technical solutions to problems afflicting next-generation products independently.[68] That is an imperfect state of affairs because firms selling technological goods to consumers remain vulnerable to infringement claims and owners of proprietary technology must assert their rights ex post to secure compensation. Where users develop their own technologies without copying an infringed patent, they enjoy no "clean room" defense.[69] This has likely generated a perception — whether justified or not — that some patents do not drive innovation and protect against copying, but simply tax those who develop and market technologies.[70]

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64. FED. TRADE COMM'N, *supra* note 10, at 80–89.

65. *See id.* at 81–82.

66. State St. Bank & Tr. Co. v. Signature Fin. Grp., Inc., 149 F.3d 1368, 1373 (Fed. Cir. 1998), *overruled by* In re Bilski, 545 F.3d 943 (Fed. Cir. 2008), *aff'd on other grounds*, Bilski v. Kappos, 561 U.S. 593 (2010).

67. *See, e.g.*, Kevin M. Baird, *Business Method Patents: Chaos at the USPTO or Business as Usual?*, 2001 U. ILL. J.L. TECH. & POL'Y 347, 348 (2001); Megan M. La Belle & Heidi Mandanis Schooner, *Big Banks and Business Method Patents*, 16 U. PA. K. BUS. L. 431, 446–48 (2014); Jeff Kettle, *Congress Giveth and Taketh Away: A Look at Section 18 of the America Invents Act and the Review of Business Method Patents*, 94 J. PAT. & TRADEMARK OFF. SOC'Y 201, 204, 206 (2012). There is evidence, however, that Internet business method patents issuing after *State Street Bank* were not of lower quality than the average patent. *See* John R. Allison & Emerson H. Tiller, *The Business Method Patent Myth*, 18 BERKELEY TECH. L.J. 987, 1077–78 (2003).

68. *See* Mark A. Lemley, *Ignoring Patents*, 2008 MICH. ST. L. REV. 19, 19–21 (2008).

69. *See id.* at 25.

70. *See, e.g.*, David S. Olson, *On NPEs, Holdups, and Underlying Faults in the Patent System*, 99 CORNELL L. REV. ONLINE 140, 143–45 (2014).

Two contemporary developments have added urgency to claims of a "patent crisis." First, competition in the lucrative smartphone industry produced aggressive litigation on an international scale.[71] Apple accused Samsung of copying proprietary features of its iPhone and other products.[72] In turn, Samsung sued for infringement of its standard-essential wireless technology.[73] That global litigation accompanied infringement lawsuits involving Motorola Mobility, Microsoft, Nokia, and HTC. The need for strategic patent holdings drove enormous patent-portfolio acquisitions, such as the Rockstar consortium's $4.5 billion acquisition of Nortel's 4G wireless technology and Google's $12.5 billion purchase of Motorola and its 17,000-patent portfolio.[74] The scale and expense of the patent war prompted commentators to openly question whether the patent system was doing anything other than suppressing competition and innovation; a 2012 New York Times article, for instance, observed that Apple and Google had spent less on R&D during 2011 than they had on patent acquisitions and litigation.[75]

The second major development was the emergence of patent-assertion entities ("PAEs") as a new business model. Such companies neither sell products incorporating technology nor build their patent holdings via prosecution. Rather, they buy patents reading on goods that already exist in the marketplace and then seek to monetize them. By not practicing technology, PAEs immunize themselves from infringement countersuits. Similarly, because they do not operate in product markets, they are resistant to traditional antitrust claims.[76]

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71. For summaries of the "smartphone patent wars," see, for example, Patrick Holvey, *The Anti-Clone Wars: Towards a Reinvigoration of the Doctrine of Patent Misuse and the Per Se Illegality of Anti-Cloning Provisions*, 10 WASH. J.L. TECH. & ARTS 153, 156–59 (2015); Kurt Eichenwald, *The Great Smartphone War*, VANITY FAIR (May 3, 2014), http://www.vanityfair.com/news/business/2014/06/apple-samsung-smartphone-patent-war [http://perma.cc/ZYM4-GM9A]**;** Agustino Fontevecchia, *Smartphone Wars: Who Wins and Who Loses from the Apple-Samsung Patent Ruling*, FORBES (Aug. 27, 2012), http://www.forbes.com/sites/afontevecchia/2012/08/27/smartphone-wars-who-wins-and-who-loses-from-the-apple-samsung-patent-ruling/#6f3e0a9714fa [https://perma.cc/CAH3-9ZTZ].

72. Nilay Patel, *Apple Sues Samsung: A Complete Lawsuit Analysis*, VERGE (Apr. 19, 2011), http://www.theverge.com/2011/04/19/apple-sues-samsung-analysis [https://perma.cc/EH7N-FSW8].

73. Britten D. Sessions & Wei Y. Lu, *Goliath v. Goliath Fallout: Repercussions of* Apple v. Samsung, 41 LINCOLN L. REV. 1, 14–15 (2014).

74. James M. Rice, *The Defensive Patent Playbook*, 30 BERKELEY TECH. L.J. 725, 757 (2015).

75. Charles Duhigg & Steve Lohr, *The Patent, Used as a Sword*, N.Y. TIMES (Oct. 8, 2012), http://www.nytimes.com/2012/10/08/technology/patent-wars-among-tech-giants-can-stifle-competition.html?_r=0 [https://perma.cc/XX5E-BXEF].

76. *See, e.g.*, Intellectual Ventures I LLC v. Capital One Fin. Corp., No. 1:13-cv-740-AJT/TRJ, 2013 WL 6682981, at *7 (E.D. Va. Dec. 18, 2013) (rejecting an antitrust theory against a large patent aggregator). *But see* Intellectual Ventures I LLC v. Capital One Fin. Corp., 99 F. Supp. 3d 610, 622–24 (D. Md. Mar. 2, 2015) (finding antitrust counterclaims

There is dispute as to whether PAEs efficiently compensate inventors who could not otherwise afford to enforce their rights or whether PAEs suppress innovation by taxing independent innovation. Critics accuse PAEs that buy and assert patents of high-tech extortion — a characterization that PAEs obviously reject. In any event, PAEs have been controversial and their practices have spurred claims that the patent system has been abused. Indeed, even the White House has condemned some PAE conduct.[77] Operating companies' allegedly partnering with PAEs through "privateering" agreements to pool and assert patents against the assignor's competitors has fueled the flames.[78]

The upshot of these developments is widespread and entrenched skepticism of the patent system. Claims that the patent regime should be reworked, or even abandoned entirely, arise with greater frequency and appear to gain more traction, but debate founded on facts is rare. The next Part of this Article explores the theoretical and empirical evidence that underlies why robust patent rights remain essential to an effective innovation policy.

III. THE ECONOMIC EFFECTS OF PATENT RIGHTS

The essential question is whether patents enhance innovation. Theory suggests that patents may variously boost and hinder R&D depending on a host of factors. Econometric and survey evidence hint at an answer but do not establish it irrefutably. The uncertainty is unfortunate and feeds debate, but it does not excuse ignorance or guess work in formulating innovation policy. Combined with economic theory and common sense, existing empirical evidence can support at least partially informed decision-making. As explained below, econometric work does not answer every material question — or even most of them — but it does allow policymakers to reject calls for outright patent abolition and permits them to make more informed judgment calls at the margin of patent policy.

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based on monopolization of an upstream technology-licensing market through targeted patent aggregation to be plausible).

77. Gene Sperling, *Taking on Patent Trolls to Protect American Innovation*, THE WHITE HOUSE (June 4, 2013, 1:55 PM), http://www.whitehouse.gov/blog/2013/06/04/taking-patent-trolls-protect-american-innovation [https://perma.cc/8GRC-G3CN].

78. *See, e.g.*, Joshua D. Wright & Douglas H. Ginsburg, *Patent Assertion Entities and Antitrust: A Competition Cure for a Litigation Disease?*, 79 ANTITRUST L.J. 501, 502 (2014).

A. The Economic Relationship Between Patents, Innovation, and Welfare

A basic economic premise underlies the patent system: technologies are expensive to invent but easy to copy. Thus, absent a Pigovian subsidy or a property right,[79] positive externalities will cause suboptimal investment in innovation.[80] This is the classic "public goods" narrative, which warns that easily appropriated information will be under-produced in a free market. One solution is a patent that allows an inventor to prevent third parties from copying her technology. That preventative rationale underlies patent systems around the world, perhaps also reflecting an intuition that inventors deserve exclusive rights against free riders who would rather take others' ideas than create their own.

In some important industries, public-goods theory accurately captures the nature of invention. The standout example is pharmaceuticals, in which private firms pour billions of dollars into R&D.[81] Successful drugs are susceptible to reverse engineering at relatively modest cost by generic firms. It is widely understood that, absent an alternative reward structure like regulatory exclusivity or suitably tailored prizes, innovation in the life sciences industry would suffer catastrophic decline without patent protection.[82]

Unfortunately, the classic narrative fails to reflect real-world complications that often arise outside of the life sciences. The workings of some technologies — especially methods used to build products — are not discernible at a low cost relative to the expense of initial invention. In some such cases, inventions are not public goods at all, meaning that trade-secret protection allows inventors to appropriate the value of their discoveries. Even if third parties can ultimately decipher a technology through reverse engineering, the cost and time of doing so may allow the inventor to secure the necessary financial return to have induced efforts to invent ex ante. Elsewhere, copying is feasible, but its impact on incentives to invent may still be modest. For instance, in settings where innovation entails rapid in-

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79. *See* Lily L. Batchelder et al., *Efficiency and Tax Incentives: The Case for Refundable Tax Credits*, 59 STAN. L. REV. 23, 44 (2006) (explaining that "Pigouvian subsidies correct for positive externalities by subsidizing the desired behavior so that the market price reflects the social value of the good").

80. *See* Kenneth J. Arrow, *Economic Welfare and the Allocation of Resources for Invention*, *in* THE RATE AND DIRECTION OF INVENTIVE ACTIVITY: ECONOMIC AND SOCIAL FACTORS 609, 609 (1962).

81. *See* PHRMA, 2015 PROFILE BIOPHARMACEUTICAL RESEARCH INDUSTRY 35 (Apr. 2015), http://www.phrma.org/sites/default/files/pdf/2015_phrma_profile.pdf [https://perma.cc/EM2E-WN5V] (reporting that the average cost of developing a drug–including failure costs–from the 2000s to the early 2010s was $2.6 billion).

82. *See* Burk & Lemley, *supra* note 2, at 1586, 1615-1619.

cremental improvement over the status quo, an inventor's reward may lie in being the first to market the latest technology.[83] That result is pronounced in network industries, where first-mover advantage can bestow great benefits.[84] More generally, competition itself can drive firms to devote R&D to improving their product offerings. Darwinian survival may be among the most powerful incentives to invent.[85]

Those complicating factors do not suggest that patents are unimportant. Rather, they reveal that neither all nor even most inventions fall into the neat category of "public goods." Thus, patents form part of a larger universe of incentives — competition, first-mover advantage, trade-secret protection, and beyond — that collectively bestow the net incentive to invent. Sometimes, the absence of patent protection would not lead inventors to abandon R&D investment, such as where the expected value of R&D without patents exceeds the innovator's reservation return.[86] Nevertheless, we would expect that introducing patents would increase the net incentive to invent a first-generation technology.

Other things being equal, strengthening the patent grant will enhance the incentive to invest in R&D to create a pioneer good or method. By giving an inventor a broader right to exclude, patent law increases the expected value of innovating. One tradeoff is that broadening the exclusive right increases the deadweight loss generated by any market power that flows from the patent.[87] When more competition in a product market increases social welfare — as is likely the case in markets that are not natural monopolies — then it is possible to enhance efficiency by narrowing the patent grant, but only if the welfare benefits of greater competition exceed the diminished incentive to invent.[88]

The discussion thus far frames the welfare issue as whether increased patent scope raises efficiency, by weighing the creation of value through enhanced innovation against the reduction of value through product-market competition. A complex literature has emerged on how best to adjust the two levers of a patent's duration

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83. *See* BURK & LEMLEY, *supra* note 48, at 43–44.

84. *See, e.g.*, Ashutosh Bhagwat, *Unnatural Competition?: Applying the New Antitrust Learning to Foster Competition in the Local Exchange*, 50 HASTINGS L.J. 1479, 1494 (1999).

85. *See, e.g.*, J. Jonas Anderson, *Secret Inventions*, 26 BERKELEY TECH. L.J. 917, 950 (2011).

86. *See, e.g.*, Lori B. Andrews, *The 'Progress Clause': An Empirical Analysis Based on the Constitutional Foundation of Patent Law*, 15 N.C. J.L. & TECH. 537, 566–67 (2014).

87. It bears emphasizing that a patent grants market power only if there is consumer demand for the claimed product or method and, after the patent issues, there are no good substitutes for the claimed invention. *See* Ill. Tool Works Inc. v. Independent Ink, Inc., 547 U.S. 28 (2006) (holding that patents do not presumptively confer market power).

88. *See, e.g.*, Vincenzo Denicolo, *Patent Races and Optimal Patent Breadth and Length*, 44 J. INDUS. ECON. 249, 263 (1996).

and breadth to maximize economic welfare.[89] The goal is to bestow the requisite expected return on inventors while minimizing the deadweight loss imposed by patent protection.[90]

There is, however, another complicating factor. Innovation is generally cumulative, meaning that it builds on the prior art. A single act of invention can have spillover effects on subsequent inventions, as when — for example — U.S. military spending yields distinct private-market applications or Tesla's research on car batteries produces Solar Roof and Powerwall technologies. Often, the inventor and improver are not the same entity. Hence, expanding patent scope not only diminishes competition in the downstream product market but might also affect how sequential innovation may unfold. Theoretically, a broad patent may limit the claimed invention's spillover effect.

Innovation sometimes entails sporadic, transformative leaps over the status quo, and, in those instances, the optimal scope of pioneer patents depends on the reward/deadweight-loss tradeoff just discussed. More often, though, an invention entails a modest step beyond the prior art, with innovation flowing through a steady stream of incremental improvements that build on prior work. The question then becomes how best to direct the path of technological development. One answer is to grant broad exclusive rights to the inventor of the breakthrough technology, thus allowing her to direct future improvement. This avoids divided ownership rights that would exacerbate coordination challenges and produce negative externalities. From that perspective, it would be a mistake to grant the pioneer inventor a narrow right that leaves improvers free to practice their claimed refinements without the first inventor's permission.

Law professor Edmund Kitch famously argued that a pioneer inventor, bestowed with broad patent rights, can best coordinate his technology's development.[91] There is reason to think that this avenue works well when transaction costs are surmountable, so that it is feasible for the pioneer both to identify suitable improvers and to negotiate licenses with them. In industries where patent rights are relatively clear and discrete in number relative to a sold product, and where in-

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89. *See, e.g.*, Richard Gilbert & Carl Shapiro, *Optimal Patent Length and Breadth*, 21 RAND J. ECON. 106 (1990); Paul Klemperer, *How Broad Should the Scope of Patent Protection Be?*, 21 RAND J. ECON. 113 (1990); Frederic M. Scherer, *Nordhaus' Theory of Optimal Patent Life: A Geometric Reinterpretation*, 62 AM. ECON. REV. 422 (1972).

90. *See* Gideon Parchomovsky & Peter Siegelman, *Towards an Integrated Theory of Intellectual Property*, 88 VA. L. REV. 1455, 1462 (2002) (explaining that patents can create deadweight loss "because some consumers who would be willing to pay more for the product than its marginal cost are unable to purchase it from the monopolistic patentee; the gains from trade that would be available in a competitive market are lost as a result of the patentee's monopoly").

91. Edmund W. Kitch, *The Nature and Function of the Patent System*, 20 J.L. & ECON. 265, 276 (1977) (noting that a single inventor with broad property rights can best coordinate development of technology).

novation tends not to advance rapidly, broad patents likely provide the breakthrough inventor an appropriate reward and direct follow-on improvements.

Matters become more complicated, however, when innovation is continuous, widespread, and rapid.[92] In such cases, transaction costs rise and make it more difficult for a pioneer to identify and negotiate with the full universe of suitable improvers.[93] Some economic literature predicts that, in such contexts, a broad pioneer patent may inhibit innovation by suppressing follow-on innovation.[94] The problem may be that although the first inventor has ample incentive to devote the requisite R&D, subsequent improvers may not. If improvers could not market their second-generation technologies without a license to an earlier pioneer patent, they may have a weak bargaining position. Unable to secure a sufficient proportion of the value of improvements, follow-on inventors may decline to invest in socially worthy research.[95] An obvious "solution" would be to narrow pioneer patents, yet doing so may inefficiently compromise incentives to invent first-generation technologies.[96]

Problems also arise when the number of discrete, patent-eligible technologies residing within a single product increases. In times past, many inventions were mechanical and the object of a small number of patents.[97] Today, with the rise of microelectronics and software, high-tech products routinely implicate thousands of patents each.[98] If ownership rights in those technologies are dispersed, the result is a Cournot complements problem.[99] As complementary assets under divided ownership, such patents hinder technology firms that want to manufacture and sell new-generation products to consumers. Under atomized ownership, each owner of a complementary patent will charge its own monopoly price, disregarding the negative externalities of that pricing decision on demand for licenses to other complementary patents. The result may be royalty stacking, in which technology

92. *See* Mark A. Lemley, *The Economics of Improvement in Intellectual Property Law*, 75 TEX. L. REV. 989, 1044–62 (1997).

93. *Id.* at 1048–72.

94. *See* Merges & Nelson, *supra* note 8, at 870.

95. *See* Suzanne Scotchmer, *Standing on the Shoulders of Giants: Cumulative Research and Patent Law*, 5 J. ECON. PERSP. 29, 32 (1991); *see also* James Bessen & Eric Maskin, *Sequential Innovation, Patents, and Imitation*, 40 RAND J. Econ. 611, 611 (2009) (arguing that patent protection is not as useful in spurring innovation that is both sequential and complementary).

96. *See* Scotchmer, *supra* note 95, at 39.

97. *See* Merges, *supra* note 61, at 585 ("[F]or Jefferson, if you put technology in a bag and shook it, it would make some noise."); Mark A. Lemley & Carl Shapiro, *Patent Holdup and Royalty Stacking*, 85 TEX. L. REV. 1991, 1992 (2007).

98. *See, e.g.*, Michael A. Carrier, *Resolving the Patent-Antitrust Paradox Through Tripartite Innovation*, 56 VAND. L. REV. 1047, 1091 (2003); Mark A. Lemley & A. Douglas Melamed, *Missing the Forest for the Trolls*, 113 COLUM. L. REV. 2117, 2174 (2013).

99. *See* Lemley & Shapiro, *supra* note 97, at 2013.

users must separately negotiate licenses from many different sources to sell a given product.[100] Related to that issue is the anticommons problem, which arises when property rights become narrow and numerous to the point that transaction costs inhibit valuable exchange. The fact that some patents employ vague claim language exacerbates the problem, as patents' claims may overlap with one another, further frustrating efforts to negotiate clearing positions. Such conditions can result in a "patent thicket" through which firms wishing to market new products must wade.[101]

Although royalty-stacking and anticommons phenomena hinder the efficacy of the patent system, they do not mean that patents inhibit innovation overall. To navigate high-transaction-cost licensing environments, technology companies use private-ordering solutions such as patent pools, portfolio cross licenses, and standard-setting organizations.[102] New business models have emerged to bridge the gap between infringed IP rights and technology users. Some of these models are controversial, most notably PAEs. Other companies, like defensive patent-buying funds, focus on achieving clearing positions rather than asserting patents and may facilitate the commercialization of technology.[103] The result of such collaborative efforts and new businesses may be a desirable flow of value to upstream inventors as well as active downstream commercialization of technology. Of course, no solution is perfect, and some of the private-ordering efforts discussed above may inhibit competitive entry into product markets.

Finally, the quality of issued patents may affect the social-welfare implications of the patent system. If a set of patents is likely to be invalid or not infringed, their collection and assertion against technology users that independently develop and market products are likely to suppress innovation.[104] That effect is especially likely if the patent assertion takes place ex post — that is, after the accused infringers are already using the claimed technologies — rather than ex ante, when technology transfer flows from patentees to downstream firms that wish to commercialize inventors' insights.[105] In 2008, fellow economists Joseph Farrell and Carl Shapiro presented an economic model

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100. *See id.* at 1993.

101. *See* Carl Shapiro, *Navigating the Patent Thicket: Cross Licenses, Patent Pools, and Standard Setting*, 1 INNOVATION POL'Y & ECON. 119 (2000).

102. *See id.* at 122.

103. *See* FED. TRADE COMM'N, *supra* note 10, at 65–66 (explaining that defensive aggregators acquire patents to "take them off the street", making them unavailable to PAEs, and licensing them to their members).

104. *See id.* at 1; FED. TRADE COMM'N, TO PROMOTE INNOVATION: THE PROPER BALANCE OF COMPETITION AND PATENT LAW AND POLICY 5–7 (Oct. 2003), https://www.ftc.gov/sites/default/files/documents/reports/promote-innovation-proper-balance-competition-and-patent-law-and-policy/innovationrpt.pdf [https://perma.cc/QW8P-HDR2].

105. *See* FED. TRADE COMM'N, *supra* note 10, at 31–72.

indicating that weak patents can have strong, adverse economic effects, "raising downstream marginal costs and thus moving the downstream price closer to the monopoly price."[106] They concluded that, at least as a matter of theory, "these effects do not merely worsen the ex post deadweight loss from patents. Perhaps worse, they distort the innovation incentives that patents are meant to provide."[107] Further still, weak patents may "lead to costly litigation, they can create a danger of hold-up (both of users and of subsequent innovators), and they can induce defensive patenting, which can itself lead to yet more weak patents in a vicious cycle."[108]

This brief overview of the economics of patents and innovation reveals a complex, interconnected web of incentives that collectively spur or deter R&D investment. In this environment, generalizations and universal proclamations inevitably overlook nuances and important tradeoffs. The ideal patent grant in one industrial setting is unlikely to instill preferred incentives in dissimilar markets. Nevertheless, the economic literature yields valuable insights. Economic models predict that, for a given invention, expanding patent scope increases the incentive to invent. Weak patent protection may therefore lead to suboptimal investment in technological development.[109] Theory suggests that heavily cumulative innovations change the nature of the optimal patent grant, but it does not support the idea that patent abolition is the preferred solution. Rather, adjusting the scope of pioneer patents may achieve a desirable balance between the original and follow-on inventors' incentives. As to the royalty-stacking and anticommons effects that could arise in certain markets, economics suggests that vertical integration and suitable, inter-competitor collaboration may ameliorate those conditions and increase output.[110] Finally, theory indicates the assertion of weak patents may retard innovation.[111]

Ultimately, of course, it is useful for policymakers to employ theory as a predictive tool in the absence of clear data. It also provides an organizing principle with which to analyze a complex body of incentive effects that individually point in different directions. But it is not sufficient to stop at theory to achieve the best policy outcome. One must also examine the empirical question that theory alone cannot answer: do patents actually enhance R&D, and is today's U.S. patent

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106. Joseph Farrell & Carl Shapiro, *How Strong Are Weak Patents?*, 98 AM. ECON. REV. 1347, 1362 (2008).

107. *Id.*

108. *Id.*

109. *See generally* James J. Anton et al., *Policy Implications of Weak Patent Rights*, 6 INNOVATION POL'Y & ECON. 1 (2006).

110. *See, e.g.*, Lemley & Melamed, *supra* note 98, at 2157–59.

111. *See, e.g.*, Joseph Farrell & Carl Shapiro, *How Strong Are Weak Patents?*, 98 AM. ECON. REV. 1347, 1361–62 (2008).

system optimally tailored to maximize innovation? It is to those fundamental, factual questions that we now turn, beginning with a discussion of the econometric challenges that make facts difficult to discern from the data.

B. Difficulties that Afflict Empirical Measurement of How Patents Affect Innovation

Before recounting the evidentiary literature on patents and innovation, it is worth explaining some of the econometric challenges. Patent systems have existed in various forms across many countries for over a century.[112] One might imagine, then, that there would be abundant data to indicate whether patents drive technological advance. Unfortunately, several problems hinder the extraction of robust, usefully broad conclusions.[113] Although many studies attempt to overcome those difficulties, generally their implications are susceptible to competing interpretations. That is because there are limits to what one can reliably draw from the empirical literature.

As a threshold issue, it is difficult to measure innovation. Technological advance takes myriad forms, from subtle tweaks to manufacturing processes to pioneer inventions that give birth to previously unimagined products. Such eclectic improvements over the status quo are often not easily quantifiable. No database identifies every innovation in an economy.[114] Unable to find data on innovation, econometricians must use proxies. Many studies use R&D expenditures, which are an input to the process that results in innovation.[115] While somewhat useful, looking at inputs give researchers an imperfect view on the ultimate output of innovation. Another common proxy is productivity gains, which are difficult to measure accurately and to isolate.[116]

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112. *See, e.g.*, Chris Dent, *'Generally Inconvenient': The 1624 Statute of Monopolies as Political Compromise*, 33 MELB. U. L. REV. 415 (2009).

113. *See generally* Lisa Larrimore Ouellette, *Patent Experimentalism*, 101 VA. L. REV. 65 (2015).

114. Nevertheless, some economists have made use of innovation surveys. *See, e.g.*, Daniele Archibugi & Mario Pianta, *Measuring Technological Change Through Patents and Innovation Surveys*, 16 TECHNOVATION 451, 451 (1996); 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, 1265 (2009); Dominique Guellec & Bill Pattinson, *Innovation Surveys: Lessons from OECD Countries' Experiences*, 27 SCI. TECH. INDUS. REV. 77, 78 (2001); *see also* Jacques Mairesse & Pierre Mohnen, *Using Innovation Surveys for Econometric Analysis*, *in* 2 HANDBOOK OF THE ECONOMICS OF INNOVATION 1130, 1131 (2010) (explaining the uses and limitations of innovation surveys).

115. *See, e.g.*, Iain Cockburn & Zvi Griliches, *Industry Effects and Appropriability Measures in the Stock Market's Valuation of R&D and Patents*, 78 AM. ECON. REV. 419, 422 (1988).

116. *See, e.g.*, Alexander Silverman, Note, *Myth, Empiricism, and America's Competitive Edge: The Intellectual Property Antitrust Protection Act*, 43 STAN. L. REV. 1417, 1430–33 & n.61 (1991).

Other proxies include R&D flows and innovation surveys.[117] Finally, studies also use the number of patent grants, which are a measurable output of innovation.[118] That proxy is also imperfect.[119] First, patent counts omit potentially important innovation that occurs outside the IP system. Second, more patents do not necessarily mean more innovation. If a government strengthens a patent grant, for instance, then other things being equal it makes obtaining a patent more valuable. We would thus expect to see more people applying for patents and, in turn, more patents issued. That phenomenon may arise regardless of whether strengthening the patent grant enhances, reduces, or has no effect on innovation.

Another basic problem arises in measuring patent strength. To estimate the correlation between greater patent protection and more innovation, one must quantify the explanatory and dependent variables. A simple solution is to look at the patent term's duration, but that factor alone fails to account for a host of qualities relevant to patent strength. The scope of an inventor's exclusive right is especially important, but that is a probabilistic concept until the courts rule on infringement. Nevertheless, econometricians use the best proxies availavailable, including those for patent breadth.

A further problem is a lack of heterogeneity in patent policies between countries.[120] Common approaches deny empiricists natural experiments to test how a change in the patent system of an otherwise-comparable economy alters innovation vis-à-vis similar economies that did not make such a change. If otherwise similarly placed states adopted patent laws with differing approaches to scope, duration, eligibility, or remedies, then that situation would create useful natural experiments. Gauging the effects of different patent policies is more difficult under relative uniformity, which has accelerated under the Agreement on Trade-Related Aspects of Intellectual Property Rights ("TRIPS").[121]

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117. *See, e.g.*, Bronwyn H. Hall et al., *Measuring the Returns to R&D*, *in* 2 HANDBOOK OF THE ECONOMICS OF INNOVATION 1034, 1067–70 (2010).

118. *See, e.g.*, Paroma Sanyal, *Understanding Patents: The Role of R&D Funding Sources and the Patent Office*, 12 ECON. INNOV. & NEW TECH. 507, 507 (2003).

119. *See, e.g.*, Zvi Griliches, *Patent Statistics as Economic Indicators: A Survey*, 28 J. ECON. LITERATURE 1661, 1666 (1990); Ignatius Horstmann et al., *Patents as Information Transfer Mechanisms: To Patent or (Maybe) Not to Patent*, 93 J. POL. ECON. 837, 838 (1985). Nonetheless, there is evidence that patent counts correlate with the introduction of new products. *See generally* William S. Comanor & F.M. Scherer, *Patent Statistics as a Measure of Technical Change*, 77 J. POL. ECON. 392 (1965).

120. *See* Ouellette, *supra* note 113, at 68.

121. John F. Duffy, *Harmony and Diversity in Global Patent Law*, 17 BERKELEY TECH. L.J. 685, 686–88 (2002); *cf.* Donald S. Chisum, *Patentability Under TRIPS: The Need for Uniformity*, 2 INDIAN J.L. & TECH. 1, 4 (2006) (arguing that full harmonization is warranted).

Other statistical difficulties stymie efforts to measure the link, if any, between patents and innovation. For example, trying to estimate the relationship between the number of patents that firms acquire and the firms' investment in R&D is complex. Simultaneity bias may arise if having more patents leads to more R&D and if greater R&D causes a firm to apply for more patents. In that case, patents would be both a cause and result of R&D, creating an endogeneity problem. Misspecifications may also occur. An omitted variable may drive both patent counts and R&D, biasing a measured correlation between patent numbers and R&D. In studies that try to explain innovation with multiple explanatory variables beyond patent strength, multicollinearity may arise if patent strength and the other explanatory variables are correlated with one another.

Most importantly, correlation does not imply causation. Suppose that time-series data revealed a statistically significant correlation between patent counts (the explanatory variable) and private R&D investment (the dependent variable). It is possible that the two variables trended in the same direction over time for reasons not captured in the model. For instance, non-IPR factors like macroeconomic growth may drive R&D and also spur firms to patent, potentially creating a meaningless correlation between patents and R&D. In short, even if studies consistently revealed a statistically significant correlation between patents and innovation, that observation would not necessarily mean that patents and innovation have any causal relationship. The outcome could be a zero-sum game, in which patents neither add to nor detract from scientific progress.

Of course, it is certainly possible and even likely that patents may spur R&D and in turn innovation, such that a positive correlation would reflect that phenomenon. Clearly, empirical evidence that patent counts do not correlate with R&D would be telling, but most studies do not find such a result.[122] The data and empirical techniques available to date do not allow economists to extrapolate irrefutable conclusions. Such limitations stem from the messy reality of studying variously incomplete, interconnected, fluid, and relatively homogeneous phenomena. Yet that does not mean we are unable to derive meaningful insights from the data. Economic theory in particular can help researchers to draw conclusions from statistical evidence that are open to competing interpretations. As Part IV explains, the better conclusion from the evidence to date is that a strong patent system is beneficial and should remain at the heart of U.S. innovation policy.

122. *See infra* Part III.C.1.a.

C. Econometric Studies Have Linked Patents to Innovation

In some commentators' views, there is no empirical support for the proposition that patents spur innovation.[123] That argument ignores abundant empirical work finding that patent strength and R&D expenditures are correlated.[124] So, too, research shows that strong IP rights are associated with economic growth in developed economies.[125] Firms with stronger patent holdings tend to perform better.[126] Surveys reveal that patents contribute to incentives to invest, most acutely in the biopharmaceutical and medical device fields but elsewhere to varying degrees as well.[127] There is also historical evidence connecting strong patent rights to technological advancement.[128] While the evidence is subject to competing interpretations — and even statistically significant correlations between patent counts and R&D are susceptible to competing interpretations[129] — it is certainly consistent with the proposition that patents materially spur innovation. Coupled with the powerful economic rationale for a patent system and the demonstrably superior innovation in IPR-intensive industries, the most compelling reading is that patents serve a valuable function within a larger innovation platform. This does not mean that today's patent system is perfectly calibrated, however. There is reason to think that proper reform could boost innovation even further. Nevertheless, calls for outright abolition, severe dilution, and even for a

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123. *See supra* Part II.A.

124. *See infra* Part III.C.1.a.

125. *Id.*

126. *See, e.g.*, Feng-Jui Hsu et al., *An Empirical Study on the Relationship Between R&D and Financial Performance*, 3 J. APPLIED FIN. & BANKING 107, 108 (2013) (finding that "firm performance is positively correlated with the number of patents the firm owns"); *see also* Gary L. Lilien & Eunsang Yoon, *Determinants of New Industrial Product Performance: A Strategic Reexamination of the Empirical Literature*, 36 IEEE TRANSACTIONS ON ENGINEERING MGMT. 3, 3–8 (1989) (showing that firms with more patents are better able to innovate and improve existing products).

127. *See infra* Part III.C.1.c.

128. Beyond the sources discussed in Part III.C.1, *infra*, see B. ZORINA KHAN, THE DEMOCRATIZATION OF INVENTION: PATENTS AND COPYRIGHTS IN AMERICAN ECONOMIC DEVELOPMENT, 1790–1920 (2005) (exploring how the U.S.'s uniquely strong patent system in the nineteenth century played a role in the country's technological development); see also Naomi R. Lamoreaux & Kenneth L. Sokoloff, *Inventors, Firms, and the Market for Technology in the Late Nineteenth and Early Twentieth Centuries*, *in* LEARNING BY DOING IN MARKETS, FIRMS AND COUNTRIES 19, 19–25 (1999) (explaining how "an extensive trade in new technological ideas did develop over the course of the nineteenth century, supported by the patent system and the emergence of information channels and intermediaries that facilitated the sale of patents at arm's length"). *See generally* Kenneth L. Sokoloff, *Inventive Activity in Early Industrial America: Evidence from Patent Records, 1790–1846*, 48 J. ECON. HIST. 813 (1988) (linking patenting activity from 1790 to 1846 to expanding markets, which spurred incentives to invent).

129. *See, e.g.*, David E. Adelman & Kathryn L. DeAngelis, *Patent Metrics: The Mismeasure of Innovation in the Biotech Patent Debate*, 85 TEX. L. REV. 1677, 1707 n.131 (2007).

targeted narrowing of the patent system by taking certain areas of inventive activity outside the scope of patent protection are unsupported by the ample evidence.

The following Section addresses the relevant empirical literature in four subparts. It begins by discussing the literature that examines the correlation between patent strength and R&D. It then addresses survey evidence of the patent system's impact in inducing firms to innovate. Third, it summarizes key studies on the role that patents play for start-ups in attracting venture capital. Finally, it explores the empirical literature showing the circumstances in which patents can hinder innovation.

1. Do Patents Boost Innovation? Empirical Evidence

For ardent skeptics of the IP system, the admittedly imperfect empirical literature likely will not change their minds. It is possible to explain statistically significant correlations between patent strength and R&D as reflecting something other than a causal relationship between patents and innovation. And it is true that some of the most prominent studies collecting and analyzing cross-country data to glean insights into such correlations are now aged[130]. But claims that the incentive-to-invent rationale underlying the patent system lacks empirical support are simply incorrect.

Those who find the economic justification for a patent system convincing encounter much support in the relevant empirical research. As the following review shows, the evidence is consistent with the proposition that patents lead to greater investment in R&D.

a. Many Studies Find a Statistically Significant Correlation Between Patent Strength and R&D Investment or Economic Growth

IP rights strength positively correlates with R&D investment, at least in developed countries.[131] Two leading studies particularly warrant attention.

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130. *See infra* Part III.C.1.a.

131. *See, e.g.*, JONATHAN ROTHWELL ET AL., BROOKINGS, PATENTING PROSPERITY: INVENTION AND ECONOMIC PERFORMANCE IN THE UNITED STATES AND ITS METROPOLITAN AREAS 8 (2013) ("R&D spending since 1953 is highly correlated with patenting and the patent rate."); John Bound et al., *Who Does R&D and Who Patents?*, *in* R&D, PATENTS, AND PRODUCTIVITY 21, 51 (1984) (finding "a strong relationship" between firms that conduct R&D and that patent, and noting that prior work "has shown a strong contemporaneous relationship of R & D and patent applications"); Georg Licht & Konrad Zoz, *Patents and R&D: An Econometric Investigation Using Applications for German, European and US Patents by German Companies*, 49 ÉCONOMIE ET ÉCONOMÉTRIE DE L'INNOVATION 329, 350 (1998) (finding "a close relationship between R&D and patents"); Ariel Pakes & Zvi Griliches, *Patents and R&D at the Firm Level: A First Report* 5 ECON. LETTERS 377 (1980)

Using cross-country data from thirty-two nations on R&D investment and patent protection from 1981 to 1995, Kanwar and Evenson in 2003 concluded, "[t]he evidence unambiguously indicates the significance of intellectual property rights as incentives for spurring innovation."[132] They found that "[t]he strength of intellectual property protection is positively and significantly associated with R&D . . . . Thus, countries which provided stronger protection tended to have larger proportions of their GDP devoted to R&D activities."[133]

A study by Park and Ginarte six years earlier created an index of patent strength using data from sixty countries from 1960–1990 "to determine the role of IP rights in economic growth."[134] The authors concluded that "IP [rights] affect economic growth by stimulating the accumulation of factor inputs like research and development capital and physical capital" and that IP rights' "benefits to growth are from encouraging the research sector to invest and take risk," except in developing countries.[135]

A host of other empirical work similarly finds a statistically significant relationship between patent strength and R&D investment. A 2013 Brookings report observed, "[r]esearch has established that patents are correlated with economic growth across and within the same country over time" and "R&D spending since 1953 is highly correlated with patenting and the patent rate."[136] Studying U.S. data between 1980 and 2010, the report concluded that "patenting is associated with higher metropolitan area productivity" and that "the most likely explanation is that patents cause growth."[137]

In a 2012 study, Duguet and LeLarge examined the relationship between patents and innovation performance between 1997 and 1999 for the French manufacturing sector.[138] They concluded that "patents significantly promote product innovations but not process innovations."[139] In short, "patents do increase the private incentives to innovate, but through a specific, unbalanced, channel."[140]

Studying fifty-eight countries' data from 1980–2003, Hasan and Tucci found in 2010 that "countries hosting firms with higher quality

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(finding a statistically significant relationship between a firm's R&D expenditures and the number of patents it applied for and receives).

132. Sunil Kanwar & Robert Evenson, *Does Intellectual Property Protection Spur Technological Change?*, 55 OXFORD ECON. PAPERS 235, 235 (2003).

133. *Id.* at 249–50.

134. Walter G. Park & Juan Carlos Ginarte, *Intellectual Property Rights and Economic Growth*, 15 CONTEMP. ECON. POL'Y 51, 51 (1997).

135. *Id.*

136. ROTHWELL, *supra* note 131, at 4, 8.

137. *Id.* at 15.

138. Emmanuel Duguet & Claire Lelarge, *Does Patenting Increase the Private Incentives to Innovate? A Microeconometric Analysis*, 107 ANNALS ECON. & STATS. 201 (2012).

139. *Id.* at 201.

140. *Id.* at 221.

patents also have higher economic growth."[141] They also identified "some evidence that those countries that increase the level of patenting also witness a concomitant increase in economic growth."[142]

In a 2011 study, Shih-tse Lo examined the effects of Taiwanese patent reform in 1986 in response to U.S. pressure, concluding that the "patent reforms stimulated R&D spending. Industries that were highly R&D-intensive experienced an increase in their patenting in the United States. The favorable impact was most pronounced in the electronic and electrical industry."[143]

In two studies in the 1990s, Thompson and Rushing explored the relationship between patent protection and economic growth.[144] Using data from 1970 to 1985, their 1996 study found evidence that "strong intellectual property rights laws and effective enforcement policies result in more rapid economic growth in countries with an initial level of [per capita] GDP greater than or equal to $3,400 [in 1980 dollars]."[145] The authors explained this effect as presumably being due to the fact that "protection from patents is the foundation for payoffs to entrepreneurs starting off the chain of events that leads to economic expansion."[146] Expanding on those conclusions in a 1999 study, Thompson and Rushing sought further insight into the contribution that patents make to factor productivity growth.[147] They found that, "in wealthier countries, patent protection shares a positive relationship with changes in total factor productivity and, in turn, total factor productivity positive[ly] influences the rate of economic growth."[148] In short, "strong patent protection and enforcement do have a positive and significant impact on the growth of factor productivity."[149]

In 1997, Gould and Gruben analyzed cross-country data on patent protection, the relative open and closed nature of each of ninety-five countries' respective trade regimes, and country-specific characteristics.[150] They found that "the degree of patent protection[] is an important determinant of economic growth."[151] Nevertheless, the strength of the effect they measured depended on whether the econo-

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141. Iftekhar Hasan & Christopher L. Tucci, *The Innovation-Economic Growth Nexus: Global Evidence*, 39 RESEARCH POL'Y 1264, 1264 (2010).

142. *Id.*

143. Shih-tse Lo, *Strengthening Intellectual Property Rights: Experience from the 1986 Taiwanese Patent Reforms*, 29 INT'L J. INDUS. ORG. 524, 525 (2011).

144. Mark A. Thompson & Francis W. Rushing, *An Empirical Analysis of the Impact of Patent Protection on Economic Growth: An Extension*, 24 J. ECON. DEV. 67 (1999).

145. *Id.* at 68 (discussing Mark A. Thomspon & Francis W. Rushing, *An Empirical Analysis of the Impact of Patent Protection on Economic Growth*, 21 J. ECON. DEV. 61 (1996)).

146. *Id.*

147. *See generally id.*

148. *Id.* at 67.

149. *Id.* at 69.

150. David M. Gould & William C. Gruben, *The Role of Intellectual Property Rights in Economic Growth*, *in* DYNAMICS OF GLOBALIZATION AND DEVELOPMENT 209 (1997).

151. *Id.* at 210.

my in question was relatively open or closed, with the effect being stronger in the former situation.[152]

In 1986, Hall, Griliches, and Hausman observed that "there does seem to be a rather strong contemporaneous relationship between R and D expenditures and patenting, which does not disappear when we control for the size of the firm, its permanent patenting policy, or even the effects of its R and D history."[153] Their findings showed "a persistent significant contemporaneous relationship of R and D and patenting."[154]

In 1980, Pakes and Griliches examined a cross-section of 121 medium and large U.S. firms between 1968 and 1975 to determine whether patents are a good indicator of inventive activity.[155] Although they identified a need for longer and larger samples, they provisionally concluded that "patents do measure something systematic, something that is associated with R&D activity. This relationship is especially strong at the cross-sectional level, where it reflects reasonably permanent differences between firms."[156]

Unsurprisingly, empirical evidence that patents drive innovation in pharmaceuticals is especially strong.[157] More generally, there is evidentiary support for the core proposition underlying the economic case for patents: investment in R&D will be suboptimal if the investing firm has limited ability to internalize the ensuing value.[158] Absent

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152. *Id.* at 209.

153. Bronwyn H. Hall, Zvi Griliches & Jerry A. Hausman, *Patents and R and D: Is There a Lag?*, 27 INT'L ECON. REV. 265, 281 (1986).

154. *Id.* at 282.

155. *See* Pakes & Griliches, *supra* note 131.

156. *Id.* at 381.

157. *See, e.g.*, Edwin Mansfield, *R&D and Innovation: Some Empirical Findings*, *in* R&D, PATENTS, AND PRODUCTIVITY 127, 142–43 (1984) ("[I]n the drug industry, patents seem to have a bigger impact than in other industries. According to the firms, about one-half of the patented innovations in our sample would not have been introduced without patent protection."); Bronwyn H. Hall, *Patents and Patent Policy*, 23 OXFORD REV. ECON. POL'Y 568, 574–75 (2007) (commenting that patents spur R&D in biopharmaceuticals and medical instruments); Jean O. Lanjouw & Iain M. Cockburn, *New Pills for Poor People? Empirical Evidence After GATT*, 29 WORLD DEV. 265, 265, 287 (2001) (analyzing the introduction of drug-product patents in India, finding "some, although limited, evidence of increased R&D in the mid-to late 1980s which appears to have leveled off in the 1990s," and finding with respect to malaria that, although an upward trend in research into treatments had recently disappeared, "it is hard to avoid the conclusion that the historical absence of IPRs played an important role in retarding the development of new treatments for this very important disease"); Yi Qian, *Do National Patent Laws Stimulate Domestic Innovation in a Global Patenting Environment? A Cross-Country Analysis of Pharmaceutical Patent Protection, 1978–2002*, 89 REV. ECON. & STAT. 436, 436 (2007) (finding, in a study of 26 countries that established patent laws between 1978 and 2002, that "patent laws in nations with high levels of development, education, and economic freedom do stimulate innovation").

158. *See, e.g.*, *Emmanuel Dechenaux et al*. *Appropriability and the Timing of Innovation: Evidence from MIT Inventions, 1–2* (May 2003) (Working Paper), www.nber.org/papers/w9735.pdf; *see also Emmanuel Dechenaux et al*.,*Appropriability and the Timing of Innovation: Evidence from MIT Inventions* at 24 (Apr. 2003) https://smartech.gatech.edu/bitstream/handle/1853/10720/gt_tiger_appropriability.pdf.

patent rights, firms redirect their R&D efforts toward technologies that they can protect as trade secrets.[159] Further, there is evidence linking higher rates of patenting to greater productivity at the firm level.[160] Moreover, stronger IP rights lead U.S. firms to increase overseas technology transfer.[161]

Finally, there is some evidence that patent rights correlate with greater innovation in developing countries, too. In a 2006 study, regressed data on seventy-nine countries showed that,

> Whilst the effect of IPR protection on growth depends upon the level of development, it is positively and significantly related to growth for low-and high-income countries, but not for middle-income countries. This suggests that, although IPR protection encourages innovation in high-income countries, and technology flows to low-income countries, middle-income countries may have offsetting losses from reduced scope for imitation.[162]

In 2005, Chen and Puttitanun analyzed data for sixty-four developing countries, finding "some evidence that innovations in developing countries are indeed positively and significantly impacted by IPRs, and the levels of IPRs exhibit a U-shaped relationship with per capita GDP."[163]

("Our empirical results provide strong support for the view that the ability to appropriate returns is important for inventions whose success is highly uncertain.").

159. Petra Moser, *How Do Patent Laws Influence Innovation? Evidence from Nineteenth-Century World's Fairs*, 95 AM. ECON. REV. 1214, 1214 (2005).

160. Anil B. Deolalikar & Röller Lars-Hendrick, *Patenting by Manufacturing Firms in India: Its Production and Impact*, 37 J. INDUS. ECON. 303, 303 (1989) (examining panel firm-level data from 1975 to 1979 from India and concluding that, "despite the limited protection of intellectual property rights in India, patenting is associated with a significant increase in total factor productivity growth at the firm level").

161. *See* Lee Branstetter, Raymond Fisman & C. Fritz Foley, *Do Stronger Intellectual Property Rights Increase International Technology Transfer? Empirical Evidence from U.S. Firm-Level Data* 25 (Nat'l Bureau of Econ. Research, Working Paper No. 11516, July 2005), http://www.nber.org/papers/w11516 [https://perma.cc/M6Q6-PXHD].

162. Rod Falvey et al., *Intellectual Property Rights and Economic Growth*, 10 REV. DEV. ECON. 700, 700 (2006).

163. Yongmin Chen & Thitima Puttitanun, *Intellectual Property Rights and Innovation in Developing Countries*, 78 J. DEV. ECON. 474, 477 (2005); *see also* Keith E. Maskus & Mohan Penubarti, *How Trade-Related Are Intellectual Property Rights?*, 39 J. INT'L ECON. 227, 227 (1995) (finding that "increasing patent protection has a positive impact on bilateral manufacturing imports into both small and large developing economies").

b. Some Studies Find a Statistically Insignificant Correlation Between Patent Strength and R&D Investment or Economic Growth

As the previous Section reveals, voluminous evidence links stronger patents with greater R&D investment at the firm level and richer macroeconomic growth. Policymakers should not take lightly the findings of that empirical literature, which leans heavily against any systematic weakening of patent rights, let alone abolition. Nevertheless, the econometric work to date is not unanimous in linking strong IP rights and innovation. The following Section explores leading work that has found no or statistically insignificant evidence of a relationship between patents and technological advance.

Sakakibara and Branstetter undertook an interesting study in 2001 on the reform of the Japanese patent system, which took place under U.S. pressure.[164] Prior to 1988, Japanese law permitted a qualifying inventor to obtain just one claim per patent.[165] Under U.S. law, by contrast, a single patent typically included many independent and dependent claims.[166] Also, the Japanese system allowed an inventor narrower exclusive rights limited to the used technology.[167] The 1980s was an era of expanding patent rights in America, which encouraged other countries to follow suit.[168] In 1988, Japan passed a law allowing one patent to include many claims, thus expanding the scope of a given patent.[169] The authors interviewed key Japanese stakeholders and determined that the 1988 reform was indeed a boon to inventors seeking patents.[170] The authors determined that it was more economical to obtain a single patent with multiple claims than several patents with one claim apiece, and the reforms materially increased the breadth of patent protection.[171]

If the theoretical causal relationship running from patent strength to R&D and innovation were true, then one would expect to see an increase in R&D or innovation post-1988 reform in Japan after controlling for other explanatory factors. While the 1980s were a time of generally rising R&D in Japan, Sakakibara and Branstetter nevertheless found no statistically significant evidence that patent reform plausibly contributed to greater R&D or innovation on the part of the 307 public Japanese companies on which they collected data.[172] The au-

164. Mariko Sakakibara & Lee Branstetter, *Do Stronger Patents Induce More Innovation? Evidence from the 1988 Japanese Patent Law Reforms*, 32 RAND J. ECON. 77 (2001).
165. *Id.* at 79.
166. *Id.*
167. *Id.*
168. *Id.* at 78.
169. *Id.* at 79.
170. *Id.* at 80–81.
171. *Id.*
172. *Id.* at 86, 98–99.

thors attributed particular significance to the lack of a spike in R&D at or around 1988. Further, while R&D spending by Japanese firms substantially increased in the early 1980s, there was a relative decline in 1988 and 1989 and R&D investment did not increase again until 1990.[173]

They concluded that "there was a broadly observed increase in R&D spending in the 1980s which largely predated the onset of patent reform in Japan. Robustness checks suggest that relatively little, if any, of the upturn can be reasonably ascribed to the change in Japan's patent regime."[174] Sakakibara and Branstetter warned, however, that the 1988 reforms were "not a perfect natural experiment," that their "failure to find an increase in firms' innovative output or input in response to patent reform does not prove that there was no effect," and that "it would be premature to generalize from [their] findings to other nations or other patent reforms."[175]

Another illuminative study is Hall and Ziedonis's empirical examination of patenting in the U.S. semiconductor industry between 1979 and 1995.[176] Unlike the study of Japan's 1988 patent reforms, the semiconductor study finds mixed evidence on the incentive effects of stronger patents rights. First, it determined that "large-scale [semiconductor] manufacturers have invested far more aggressively in patents during the period associated with strong U.S. patent rights, even controlling for other known determinants of patenting."[177] The evidence thus shows that U.S. semiconductor firms respond to changes in patent strength. Nevertheless, the evidence implies that the firms used patent holdings strategically, undertaking an arms war to secure market position vis-à-vis one another.[178] That phenomenon may be a function of the cumulative and often-simultaneous nature of innovation in the semiconductor industry, which may make patents more useful as strategic assets than as a means for guarding quickly evolving technologies against appropriation. The authors also found, however, that "stronger patent rights are especially critical to these firms in attracting venture capital funds and securing proprietary rights in niche product markets."[179]

In an extensive 2002 study, Josh Lerner engaged in a cross-sectional analysis of 177 changes in patent strength across sixty coun-

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173. *Id.* at 88.
174. *Id.* at 92 (emphasis omitted).
175. *Id.* at 99.
176. Bronwyn H. Hall & Rosemarie Ham Ziedonis, *The Patent Paradox Revisited: An Empirical Study of Patenting in the U.S. Semiconductor Industry, 1979–1995*, 32 RAND J. ECON. 101 (2001).
177. *Id.* at 104.
178. *Id.* at 125.
179. *Id.* at 104.

tries between 1850 and 2000.[180] He found that a country's increase in patent protection substantially affected patent filings in that country by foreign entities, but reduced patent filings by domestic residents and in Great Britain, to which he devoted individual attention.[181] Consistent with economic theory predicting an inverse-U-shaped relationship between patent strength and innovation, he found that "patent protection-enhancing shifts have a lesser impact on innovation when the nation already has strong patent protection and when its per capita gross domestic product lags behind other nations."[182] He concluded that "the failure of domestic patenting to respond to enhancements of patent protection, and the particularly weak effects seen in developing nations, were quite striking."[183]

Also noteworthy is Petra Moser's 2013 review of economic evidence on the relationship between patents and innovation.[184] He concluded,

> Overall, the weight of the existing historical evidence suggests that patent policies, which grant strong intellectual property rights to early generations of inventors, may *discourage* innovation. On the contrary, policies that encourage the diffusion of ideas and modify patent laws to facilitate entry and encourage competition may be an effective mechanism to encourage innovation.[185]

In an earlier paper, which studied evidence on almost fifteen thousand innovations among several countries at world's fairs in 1851 and 1876, the same author concluded that "patents help to determine the direction of technical change."[186]

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180. Josh Lerner, *Patent Protection and Innovation Over 150 Years* (Nat'l Bureau of Econ. Research, Working Paper No. 8977, 2002), http://www.nber.org/papers/w8977 [https://perma.cc/2U9C-N8PY].

181. *Id.* at 19–20, 27.

182. *Id.* at 2.

183. *Id.* at 28.

184. Petra Moser, *Patents and Innovation: Evidence from Economic History*, 27 J. ECON. PERSP. 23 (2013).

185. *Id.* at 40.

186. Moser, *supra* note 159, at 1214.

c. Surveys Reveal that Patents Are Critical to Innovation in the Life Sciences Sector and Relevant in Other Industries, Albeit Less so than Other Factors

Many economists question the efficacy of surveys.[187] Among other reasons, this is because what people say they will do often differs from what they will actually do, and thus market transactions reveal preferences more reliably than survey responses.[188] Nevertheless, revealed preferences are not always available to researchers, who must therefore look to stated preferences. Given the ambiguous nature of empirical studies of patent strength and innovation, there is reason to survey innovators in an effort to determine which factors drive them to invest in R&D.

Researchers have undertaken numerous surveys, but two in particular stand out: the 1994 Carnegie Mellon survey and the 1983 Yale survey.[189] This Section addresses each in turn, and concludes by referencing briefly several others. The most important takeaway is that patents are the principal means of protecting innovations in certain industries, especially in pharmaceuticals but elsewhere too, and of ancillary effectiveness compared to other appropriation mechanisms in other industries.[190] These surveys support the U.S. patent system, which plays a material appropriation function worth protecting for innovations across industries. Plainly, patents increase the cost to competitors of imitating an innovator's new products, thus making them a useful — if not always principal — means of protecting the results of R&D.[191]

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187. *See, e.g.*, W. Kip Viscusi, *Monetizing the Benefits of Risk and Environmental Regulation*, 33 FORDHAM URB. L.J. 90, 108–09 (2006); Robert H. Frank & Cass R. Sunstein, *Cost-Benefit Analysis and Relative Position*, 68 U. CHI. L. REV. 323, 341 (2001).

188. Viscusi, *supra* note 187.

189. *See generally* Wesley M. Cohen et al., *Protecting Their Intellectual Assets: Appropriability Conditions and Why U.S. Manufacturing Firms Patent (or Not)*, (Nat'l Bureau of Econ. Research, Working Paper No. 7552, 2000); Richard C. Levin et al., *Appropriating the Returns from Industrial Research and Development*, 3 BROOKINGS PAPERS ON ECON. ACTIVITY 783 (1987).

190. In addition to the Carnegie Mellon and Yale studies discussed below, see Anthony Arundel, *The Relative Effectiveness of Patents and Secrecy for Appropriation*, 30 RES POL'Y 611, 611 (2001) (analyzing data from the 1993 European Community Innovation Survey on almost 3,000 firms that engage in R&D, finding that "a higher percentage of firms in all size classes rate secrecy as more valuable than patents[,]" and concluding that a firm becomes less likely to rate "secrecy as more valuable than patents . . . with an increase in firm size for product innovations").

191. *See* Edwin Mansfield, Mark Schwartz & Samuel Wagner, *Imitation Costs and Patents: An Empirical Study*, 91 ECON. J. 907, 913 (1981) (finding that patents increase imitation costs, though, "[w]ithin 4 years of their introduction, 60% of the patented successful innovations in our sample were imitated," and noting that, in "the ethical drug industry, patents had a bigger impact on imitation costs than in the other industries, which helps to account for survey results indicating that patents are regarded as more important in ethical drugs than elsewhere") (citation omitted).

The Yale study surveyed 634 American R&D executives in over 100 manufacturing industries.[192] The goal was to determine patents' effectiveness in "preventing competitive imitation of a new process or product" as compared to secrecy, lead time, moving quickly down the learning curve, and sales or service efforts.[193] Respondents provided a numeric response ranging from 1.0 for "not at all effective" to 7.0 for "very effective."[194] The study found that, for new methods, "patents were generally rated the least effective of the mechanisms of appropriation: only 20 percent of the lines of business surveyed rated process patent effectiveness in excess of 4.0."[195] Product patents were different. For them, "[p]atents . . . were typically considered more effective than for processes," likely because of "the greater ease and desirability of maintaining secrecy about process technology."[196] Still, "lead time, learning curves, and sales or service efforts were regarded as substantially more effective than patents in protecting products."[197] The study observed that "[i]n only one industry, drugs, were product patents regarded by a majority of respondents as strictly more effective than other means of appropriation."[198] For "organic chemicals, plastic materials, and steel-mill products . . . most respondents rated patents as no less effective than the best alternative."[199]

Eleven years later, the Carnegie Mellon study surveyed 1,478 R&D labs in the U.S. manufacturing sector in 1994.[200] The researchers asked firms to rate the effectiveness of different appropriability mechanisms for their product and method innovations, including patents, secrecy, lead time, and know-how. "Effectiveness" went to how much respondents believed that "patents protect [their] firm's competitive advantage due to the patented inventions."[201]

The study found that "among large firms, patents have the highest effectiveness scores in a number of industries, including drugs, toilet preparations, gum and wood chemicals, pipes/valves, oil field machinery, switchgear, and autoparts."[202] Further, "(while not being the top mechanism) patents have average scores of at least 50% in organic chemicals, fibers, turbines/generators, motors/industrial controls, and medical equipment."[203] Compared to the earlier Yale study, "patents are still not the dominant mechanism in most industries for protecting

192. Levin, *supra* note 189.
193. *Id.* at 784.
194. *Id.* at 793–94.
195. *Id.* at 794.
196. *Id.* at 795.
197. *Id.*
198. *Id.* at 796.
199. *Id.* at 796–97.
200. Cohen, *supra* note 189.
201. *Id.* at 11.
202. *Id.* at 12.
203. *Id.*

product innovations, [but] it now appears that they can be counted among the major mechanisms of appropriation in a more sizeable minority of industries."[204] Interestingly, the respondents' principal reported reason for applying for product patents (96%) and process patents (78%) was to prevent copying, with the motive of blocking rival patents being second.[205] The least important reason for applying for patents, other than to measure internal performance, was to earn licensing revenue, with just 28% and 23% of respondents reporting that factor as a reason for patenting products and methods, respectively.[206] Notably, the authors found "the prevention of suits to be one of the most important uses of patents across all industries."[207]

Nevertheless, patents were not the most effective means of protecting innovations across all industries. The data revealed that "most firms in complex product industries do not consider patents, but first mover advantages, secrecy and the exploitation of complementary capabilities as the key means of protecting their inventions."[208] The authors stressed, however, that simply because respondents ranked one mechanism as being effective for a greater proportion of innovations does not imply "that other mechanisms are unimportant," not least because firms employ an array of appropriability mechanisms.[209]

They also sought to answer a question not previously addressed: if patents are relatively ineffective in many industries for protecting returns to innovation, why do firms in those industries patent anyway?[210] The answer: "firms can profit from patents in ways other than protecting the profits that may directly accrue to the commercialization or sale . . . of a patented innovation," including "blocking rivals from patenting related inventions, protection against infringement suits, and using patents in negotiations over technology rights."[211] The authors concluded, in comparison to the Yale study of more than a decade before, "patents may be relied upon somewhat more heavily by larger firms now than in the early 1980s."[212]

Another influential work beyond the Yale and Carnegie Mellon studies is Edwin Mansfield's 1994 survey of one hundred U.S. firms in six international manufacturing industries.[213] The Mansfield study, however, had a different focus. Instead of asking executives for their

204. *Id.* at 13.
205. *Id.* at 17–18.
206. *Id.* at 18.
207. *Id.* at 26–27.
208. *Id.* at 28.
209. *Id.* at 9.
210. *Id.* at 3–4.
211. *Id.* at 4.
212. *Id.* at 1.
213. Edwin Mansfield, *Intellectual Property Protection, Foreign Direct Investment, and Technology Transfer* (Int'l Fin. Corp. Discussion Paper No. 19, 1994).

views on the efficacy of patents as anti-expropriation mechanisms, or asking whether firms made R&D investments based on strong IP rights, Mansfield investigated how the strength of a country's IP rights regime affected U.S. private-firm technology transfer and foreign direct investment into that country.[214] He found that "the strength or weakness of a country's system of intellectual property protection seems to have a substantial effect, particularly in high-technology industries, on the kinds of technology transferred by many U.S. firms to that country."[215] Further, "this factor seems to influence the composition and extent of U.S. direct investment there, although the size of the effects seems to differ from industry to industry."[216]

A 1986 empirical study by Mansfield discerned the proportion of inventions developed in 1981–1983 that would not have been developed absent patent protection.[217] He conducted a random sample of one hundred firms from twelve industries, identifying technologies that would not have been developed in the but-for world through the firms' leading R&D executives.[218] Mansfield found that patents were essential for the development and introduction of 30 percent or more of pharmaceutical and chemical inventions, and between 10 and 20 percent of inventions in the petroleum, machinery, and fabricated metal product industries.[219] Patent protection in other industries either was less important or was not essential at all for the development and introduction of new inventions in the studied period.[220]

Last, but certainly not least, Arora, Ceccagnoli, and Cohen conducted an influential study that estimated the "patent premium," meaning the degree to which patenting marginally increases the value of an innovation.[221] To do so, they used data from the 1994 Carnegie Mellon survey discussed above.[222] They concluded that "patents are valuable for a subset of innovations, and consequently, patents do provide incentives for R&D."[223] They further found that, on average, "patents do not provide a positive (greater than unity) expected premium net of patent application costs in any industry except medical instruments. The net premium is around unity for biotech and pharmaceuticals, followed by computers, machinery, and industrial chem-

214. *Id.*
215. *Id.* at vii.
216. *Id.*
217. Edwin Mansfield, *Patents and Innovation: An Empirical Study*, 32 MGMT. SCI. 173 (1986).
218. *Id.* at 174.
219. *Id.*
220. *Id.*
221. Ashish Arora, Marco Ceccagnoli & Wesley M. Cohen, *R&D and the Patent Premium*, 26 INT'L J. INDUS. ORG. 1153 (2008).
222. *Id.* at 1154.
223. *Id.* at 1173.

icals."[224] Their study did not suggest, however, that patents do not spur R&D in industries where the patent premium is slight and innovators rely on non-patent methods of appropriation to protect their inventions. "[E]ven in industries where the patent premium is lower and firms rely more heavily upon means other than patents to protect their inventions, such as electronics and semiconductors, our estimates imply that patents stimulate R&D, though less so."[225]

d. Does Patent Strength Have an Inverse-U-Shaped Relationship with Innovation?

Theory suggests that expanding patent scope will not always enhance innovation.[226] That result is intuitive. Strengthening patent protection should enhance the incentive to invent a new product or process, but it may reduce the propensity to improve upon existing proprietary technologies. As the last Section explained, optimal patent scope depends in part on the ratio of initial-to-cumulative innovation, the number of follow-on innovators, and transaction costs. Kitch's prospect theory, which recommends granting broad patents to initial inventors to allow them to control the path of subsequent improvements, is most likely to hold in particular circumstances: where innovation is capital intensive and lumpy — for example, subject to sporadic, but material, breakthroughs — subsequent incremental enhancements are modest, and transaction costs are surmountable.[227] Those conditions exist sometimes, but not always. Where broad patents encumber follow-on R&D, it would be no surprise that expanding them further would not enhance net innovation.[228] Yet there is to date limited evidence that reflects that theory.

At least one study finds empirical support for the proposition that strengthening IP rights beyond a critical point may discourage innovation.[229] To the extent that finding reflects a causal relationship, it may

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224. *Id.*

225. *Id.*

226. *See, e.g.*, Chen & Puttitanun, *supra* note 163, at 476 (theorizing a U-shaped relationship between IPR strength and economic development).

227. *See* Burk & Lemley, *supra* note 2, at 1600–04, 1615–17; Mark A. Lemley, *Ex Ante Versus Ex Post Justifications for Intellectual Property*, 71 U. CHI. L. REV. 129, 133 (2004); *see also* John F. Duffy, *Rethinking the Prospect Theory of Patents*, 71 U. CHI. L. REV. 439 *passim* (2004) (refining the argument in favor of prospect theory).

228. *See* Ted Sichelman, *Commercializing Patents*, 62 STAN. L. REV. 341, 380–83 (2010).

229. *See, e.g.*, Yi Qian, *Do National Patent Laws Stimulate Domestic Innovation in a Global Patenting Environment? A Cross-Country Analysis of Pharmaceutical Patent Protection, 1978–2002*, 89 REV. ECON. & STAT. 436, 436, 447, 449 (2007); *see also* Josh Lerner, *Patent Protection and Innovation over 150 Years* 2 (Nat'l Bureau of Econ. Research, Working Paper No. 8977, 2002) ("[P]atent protection-enhancing shifts have a lesser impact on innovation when the nation already has strong patent protection and when its per capita gross domestic product lags further behind other nations.").

mirror evidence of an inverted-U-shaped relationship between product-market competition and innovation.[230] Nevertheless, evidence to date that greater patent strength eventually weakens incentives to invent is thin. As explored above, empirical studies reveal a statistically significant relationship between patent strength and R&D in developed countries.[231] That literature reveals no inverted-U-shaped relationship, as would exist if further strengthening of patent rights beyond a certain point correlated with diminished R&D expenditures. The implications one can reasonably draw from that literature are limited, however, in that the patent strength at issue may not have yet reached a critical tipping point. Further, it is conceivable that studies finding no statistically significant relationship between increased patent strength and R&D[232] reflect a plateau in the relationship before further expansions in patent scope would correlate with reduced R&D.[233] Ultimately, even in cumulative-innovation settings, evidence whether greater patent strength suppresses innovation is ambiguous.[234]

e. Patents May Help Startups Secure Capital Funding and Compete

There is evidence that patents serve a material role in the startup process. A 2008 survey found that 76% of venture-backed startup managers reported that venture-capital investors consider patents important to funding decisions.[235] That figure masked significant differences among industries, however, given that "60% of software firms reported that VC investors considered patents important, while that figure rose to 73% for Dun & Bradstreet ("D&B") listed biotechnology firms and 85% for D&B medical device companies."[236] The tendency of patents to contribute to venture-capital acquisition, however, is not limited to the life sciences industries. A 2001 study of semiconductor patenting, for instance, concluded from interviews that strong patent rights were important to attracting venture capital.[237] The au-

230. *See* Philippe Aghion et al., *Competition and Innovation: An Inverted-U Relationship*, 120 Q.J. ECON. 701 (2005) (finding empirical evidence of an inverted-U-shaped relationship between product-market competition and innovation).

231. *See, e.g.*, Kanwar & Evenson, *supra* note 132; Park & Ginarte, *supra* note 134; Hall, Griliches & Hausman, *supra* note 153.

232. *See, e.g.*, Sakakibara & Branstetter, *supra* note 164.

233. *Accord* Walter G. Park, *Intellectual Property Rights and International Innovation*, *in* 2 INTELL. PROP., GROWTH AND TRADE 289 (Keith E. Maskus ed., 2007); Nancy T. Gallini, *The Economics of Patents: Lessons from Recent U.S. Patent Reform*, 17 J. ECON. PERSP. 131, 139 (2002).

234. *See* Gallini, *supra* note 233, at 136.

235. 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, 1307 (2009).

236. *Id.*

237. Hall & Ziedonis, *supra* note 176.

thors emphasized "the importance of patents as an imperfect but quantifiable measure of technology that enabled technology-based trades to be made in external markets, both in financial markets (venture capital) and with suppliers and owners of complementary technologies."[238]

Of course, the efficacy of non-patent appropriation mechanisms differs from industry to industry.[239] Patents are not always well suited to driving software innovation, which tends to progress more rapidly than the prosecution process awards patents.[240] Further, the heavily cumulative nature of innovation in computer software suggests that patents should be narrow.[241] Consistent with the survey evidence recounted above, first-mover advantage and competition are more likely to drive innovation in that sector than patent protection.[242] It is thus unsurprising that patents serve a less critical function than some other factors for software firms in securing venture capital.[243] A 2007 study found patents generally to be relatively unimportant to software startups in that respect, but it nevertheless identified two potential benefits of patent protection.[244] First, patents may "support young firms in their efforts to compete" and, second, patents may "facilitate the intra-industry technology transfers upon which innovation depends in a realm of cumulative innovation."[245] They conclude:

> In the end, the point of this paper is that a serious debate about the propriety of patents in the software industry must account not only for the possibility that patents might impose substantial costs, but also for the possibility that they provide substantial benefits. Our paper contributes to the existing literature by providing a quantitative link between patenting behavior and firm success. Our work provides substantial evidence that patenting, at least in this industry, is an important part of a well-organized oper-

238. *Id.* at 110.

239. *See* Burk & Lemley, *supra* note 2, *passim*.

240. *See, e.g.*, Colleen V. Chien, The Market for Software Innovation Through the Lens of Patent Licenses and Sales (Apr. 15, 2016) (unpublished draft), https://www.law.berkeley.edu/wp-content/uploads/2016/04/Chien-SW-Draft-2.pdf [https://perma.cc/A7P3-74RN]. For a skeptical recent take on the patentability of software patents, *see* Intellectual Ventures I LLC v. Symantec Corp., 838 F.3d. 1307, 1322–29 (Fed. Cir. 2016) (Mayer, J., concurring).

241. *See* Dan L. Burk & Mark A. Lemley, *Designing Optimal Software Patents*, *in* INTELLECTUAL PROPERTY RIGHTS IN FRONTIER INDUSTRIES 92 (2005).

242. *See, e.g.*, Graham et al., *supra* note 235, at 1292–93.

243. *See* Ronald J. Mann & Thomas W. Sager, *Patents, Venture Capital, and Software Start-ups*, 36 RES. POL'Y 193, 193 (2007).

244. *Id.* at 207.

245. *Id.*

> ation, rather than a random or happenstance occurrence.[246]

Ultimately, the evidence on the role of patents in allowing firms to attract venture capital is akin to that contained in the broader econometric literature exploring the relationship between patents, R&D investment, and innovation. The evidence is strong in industries where innovation has public-good characteristics making suboptimal investment in R&D likely absent property protection.[247] Outside of those settings, patents continue to play a material part of the larger innovation-incentive environment, but they do not dominate it. It is thus not surprising that the importance of patents to venture capital, compared to incentives to invent in the first place, is less pronounced in such markets. Nevertheless, it remains true that, on the whole, the patent system plays a valuable role in helping start-ups to attract venture capital.[248]

f. There Is Some Evidence that Some PAE Behavior Harms Innovation

This Section's exploration of the empirical literature closes with a brief word on how PAEs affect innovation. This Article seeks to ground patent-based innovation policy in empiricism, and warns of the dangers of uncritically accepting popular narratives. A prominent example of strongly held views that lack a robust evidentiary foundation is PAEs, which are non-technology-practicing companies that aggregate and license patents under threat of suit. Many voices have argued that PAEs are harming inventive activity. Even the White House has proclaimed that PAEs exacted costs on innovation and economic growth.[249] Much empirical work remains to be done, however, to discern the actual market effects of patent aggregators and licensors that bear the attributes of the PAE business model.

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246. *Id.*

247. Graham et al., *supra* note 235, at 1307.

248. ARTI RAI ET AL., PATENT REFORM: UNLEASHING INNOVATION, PROMOTING ECONOMIC GROWTH & PRODUCING HIGH-PAYING JOBS, A WHITE PAPER FROM THE U.S. DEPARTMENT OF COMMERCE 3 (2010) ("[O]wning patents is significantly correlated with success in acquiring first and additional rounds of VC financing.") (citations omitted); *see also* Robert P. Merges, *Uncertainty and the Standard of Patentability*, 7 HIGH TECH. L.J. 1, 11 n.30 (1992) (collecting sources).

249. EXECUTIVE OFFICE OF THE PRESIDENT, PATENT ASSERTION AND U.S. INNOVATION (2013); *see also* Lauren Cohen et al., *Patent Trolls: Evidence from Targeted Firms* (Nat'l Bureau of Econ. Research, Working Paper No. 20322, July 2014); Stephen Kiebzak et al., *The Effect of Patent Litigation and Patent Assertion Entities on Entrepreneurial Activity*, 45 RES. POL'Y 218, 218–19 (2015); Roger Smeets, Does Patent Litigation Reduce Corporate R&D? An Analysis of US Public Firms (Apr. 2014) (unpublished manuscript), http://ssrn.com/abstract=2443048 [https://perma.cc/DY5K-3WRB]; Catherine Tucker, Patent Trolls and Technology Diffusion: The Case of Medical Imaging (Apr. 14, 2014) (unpublished manuscript), http://ssrn.com/abstract=1976593 [https://perma.cc/KG5U-LGNR].

To understand how reality can depart from conjecture, consider the Section 6(b) report on PAE conduct that the FTC released in October 2016.[250] Although it does not address the efficiency of PAEs, the case study contributes significantly to the empirical literature, revealing in particular two different business models — Litigation PAEs and Portfolio PAEs. The study unearthed evidence that Litigation PAEs, which own relatively small patent holdings, generally sue without first negotiating a license and then settle quickly, usually at a sum that is below early-stage litigation costs.[251] The report observed that such conduct is consistent with nuisance lawsuits. Based on that evidence, I supported modest reform proposals that would not affect the rights of larger patent holders.[252]

Portfolio PAEs, by contrast, behave differently. As I explained in a recent speech:

> Portfolio PAEs appear to be sophisticated firms that aggregate hundreds or thousands of patents, license their portfolios for millions of dollars apiece, and capitalize themselves through institutional and other investors. Despite making up only 9% of the licenses in the study, they generated four-fifths of the revenue. They hire specialized IP-licensing professionals and typically negotiate licenses without first suing their prospective licensees. On average, the patents they acquired were over three years younger than those that Litigation PAEs obtained.
>
> All told, Portfolio PAEs engage in conduct that is potentially consistent with an efficient aggregation service. Given the sums that change hands in arms-length transactions between Portfolio PAEs and their licensees — amounts that seem often to exceed the cost of litigation — it appears that technology users paid sums that may reflect the quality of the licensed patents. Furthermore, in aggregating thousands of presumably complementary patents into a single source, Portfolio PAEs may alleviate royalty-stacking effects associated with divided ownership of complementary property rights.[253]

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250. PAE STUDY, *supra* note 13.

251. *Id.* at 3–4.

252. *Id.* at 8–13.

253. Maureen K. Ohlhausen, Commissioner, Fed. Trade Comm'n, Remarks Before the National Press Club: The FTC PAE Study in Context 11–12 (Oct. 20, 2016),

I further explained that "it does not necessarily follow that Portfolio PAEs enhance social welfare.[254]" For example, "Portfolio PAEs may share little revenue with upstream inventors, many of their patents would not have been asserted but-for their accumulation, their licensees independently invented the claimed technologies, or that their IPR holdings are of poor quality."[255] Nevertheless, the gulf in characteristics between Litigation and Portfolio PAEs was telling and justified targeted, nuanced reform. With PAEs as with patent issues more generally, an evidentiary approach works best.

g. Summing Up

Overall, the empirical literature supports several conclusions. First, for the life sciences sector, there is a clear need for patents or for an alternative reward system to induce costly R&D vulnerable to appropriation. Second, although strong IP rights correlate with economic growth and R&D in developed countries, those empirical studies are open to competing interpretations due to potential endogeneity and simultaneity. Further, correlation does not imply causation. In short, those studies do not prove that a strong patent system leads to more innovation, though they are consistent with that proposition. Third, theory suggests that successive, incremental increases in patent scope may first increase innovation, later have little or no effect, and ultimately reduce innovation. Evidence of that phenomenon is consistent with the economic literature on cumulative innovation.

Fourth, surveys show that patents are generally an ancillary factor in driving R&D outside of biopharmaceuticals, medical devices, and manufacturing industries. Nevertheless, this does not mean patents are unimportant or irrelevant elsewhere. Patents still play a role in allowing some inventors in software, semiconductor, and other industries to guard the fruit of their R&D. Patents may not always be the principal driver of innovation, but they may enhance technical advances nonetheless. It is no indictment of the patent regime to say that firms in some industries invest in R&D because competitive threats force them to do so, first-mover advantage and network effects make doing so profitable, or that firms obtain patents for the benefit of name recognition, rather than just because patents allow them to prevent appropriation. Fifth, patents play a material business role today from startups seeking venture capital to firms striving for market position through a patent arms race. Sixth, patents influence the path of innovation.

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https://www.ftc.gov/public-statements/2016/10/prepared-remarks-commissioner-maureen-k-ohlhausen-ftc-pae-study-context.

254. *Id.* at 12.

255. *Id*.

Unsurprisingly, different observers interpret this literature differently. Hall and Harhoff conclude that "the bottom line from the empirical evidence is that the patent system provides clear incentives for innovation in only a few sectors, but that firms and industries do respond to its presence, both by making use of the system and by sometimes tailoring their innovative strategies to its presence."[256] They worry that patents form part of the institutional regime to which firms have adapted, such that changing that regime may impose "substantial short-term costs that may outweigh the long-term benefits."[257] Summarizing the literature, law professor Lisa Larrimore Ouellette concludes that "econometric studies show that patent laws affect inventor behavior, and there is some evidence that longer patent terms can promote more investment," but observes that outside pharmaceuticals "the evidence is more ambiguous on whether patents even provide a net incentive for innovation."[258]

Reviewing the relevant studies, Robert Hahn observes that the "literature on intellectual property rights has found few hard conclusions."[259] Nevertheless, he grants that some research "does indeed link stronger patent rights to social benefits" and "indicate[s] that R&D rises with IP [rights] strength."[260] Further, "the evidence clearly shows that allowing patents for federally funded research at universities and national labs has led to increased technology transfer to industry."[261] Other studies yield ambiguous results and some indicate that broad patents can inhibit cumulative innovation. Strong conclusions remain elusive because the available data is insufficient.[262]

As explained above, the statistical difficulties at play are formidable.[263] It is no surprise that, in a 1958 study for Congress, economist Fritz Machlup wrote that:

> 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

256. Bronwyn H. Hall & Dietmar Harhoff, *Recent Research on the Economics of Patents*, 4 ANN. REV. ECON. 541, 549 (2012).

257. *Id.*

258. Ouellette, *supra* note 113, at 83.

259. Robert Hahn, The Economics of Patent Protection: Policy Implications from the Literature (Oct. 30, 2003) (unpublished manuscript), http://ssrn.com/abstract=467489 [https://perma.cc/X3RB-8K82].

260. *Id.* at 39.

261. *Id.*

262. *Id.*

263. *See supra* Part III.B.

> our present knowledge, to recommend abolishing it.[264]

Mazzoleni and Nelson echoed that view forty years later, concluding their literature review with the statement: "Our lack of knowledge here clearly limits our ability to analyze intelligently the current pressing issues of patent reform."[265]

The problem for policymakers is how to extrapolate guiding principles from an empirical literature that makes causal inferences difficult. Patent strength correlates with R&D investment and economic growth in developed countries.[266] Surveys reveal that patents are sometimes critical to particular inventions, sometimes of secondary importance, and on occasion irrelevant.[267] Patents facilitate at least some forms of technology transfer and are useful to many start-ups in securing venture capital funding. Further, patents have long been an integral part of U.S. innovation policies that have produced tremendous results. Policymakers should not take these collective considerations lightly. In my view, they counsel in favor of robust IP rights protection. Admittedly, this evidence does not exclude the possibility that patents and innovation do not have a causal relationship but econometric studies facing myriad statistical challenges rarely lend themselves to firm conclusions.

The questions at the frontier of today's patent policy go beyond the binary choice of whether patents foster or retard innovation. Often, they involve incremental adjustments to patentable subject matter, permissible damage-calculation methodologies, pleading requirements, discovery limits, ownership-transparency rules, and the availability of cost-shifting for prevailing defendants, where the econometric literature does not provide clear answers. In those circumstances, it is to economic theory — coupled with priors, judgment, and inferences drawn from the evidence — that policymakers must turn.

Thus, while abolishing or severely diluting patents would be unjustified in light of the relevant evidence, it is more difficult to conclude whether more limited proposals are likely to enhance or reduce innovation at the margin. As the next Part explains, policymakers must still grapple with such questions, using guiding principles and judgment derived at least in part from a reading of the empirical and

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264. SUBCOMM. ON PATENTS, TRADEMARKS, AND COPYRIGHTS, S. COMM. ON THE JUDICIARY, 85TH CONG., AN ECON. REVIEW OF THE PATENT SYS. 80 (Comm. Print 1958).

265. Roberto Mazzoleni & Richard R. Nelson, *Economic Theories About the Benefits and Costs of Patents*, 32 J. ECON. ISSUES 1031, 1051 (1998).

266. *See supra* Part III.C.1.a.

267. *See supra* Part III.C.1.c.

theoretical evidence weighing on the relationship between patents and innovation.

IV. FASHIONING RESPONSIBLE POLICY FROM IMPERFECT INFORMATION

As an FTC Commissioner, I vote on investigations, enforcement actions, amicus briefs, and Commission reports and filings that implicate patented technology. I also participate in conferences at which policymakers from around the world debate intellectual property matters in an effort to identify the institutional designs, rules, and normative principles that best serve their respective societies. The tendency of patents to advance or restrict consumer welfare is a recurring issue in this work. Like many policymakers who enjoy the privilege and responsibility of protecting consumers, I must form views on the role of patents as part of larger U.S. innovation policy.

This Part explains why I read the theoretical and empirical literature explored in Part II to support strong patent rights. To be clear, however, favoring robust IP rights protection is not to embrace ever-broader exclusive rights or to deny that some entities can abuse patents, as they can other property rights. It is rather to defend the fundamentals of the contemporary U.S. patent system, which has served the country well, to approach questions of reform cautiously, and to insist upon evidentiary showings of harm before allowing anecdotal, but quantitatively deficient, claims of patent abuse to drive policy.

Consider what we know about patents and innovation, beginning with the relevant theory. First, when inventors invent, they discover new information. Some technologies — typically in-house manufacturing or design processes — resist copying and are thus prime candidates for trade-secret protection. Many other forms of information, however, are expensive to develop and have the public-good characteristic of non-excludability, making them vulnerable to third-party appropriation. A good example includes drug products. Because it is usually cheaper to copy a technology than to develop it in the first case, firms have an incentive to freeride on the R&D of their competitors. Thus, as with all activities generating positive externalities, suboptimal investment in the creation of technology is likely to result. Patent-created rights to exclude free-riders alleviate the public-goods issue, thus spurring more innovation.

Second, the simple act of invention itself carries limited social value until — or unless — it results in an applied technology.[268] Commercialization often requires significant capital investment beyond what was necessary to obtain a patent. Yet making a technology

268. *See* PATENT NOTICE & REMEDIES, *supra* note 13, at 69.

into a working consumable product (or part of a product), obtaining regulatory approval, and bringing the good to market also create positive externalities. Third-party competitors can often free ride off an innovator's efforts in marketing a new product. Patents incentivize firms to devote the necessary sums to transform an abstract technology claimed in a patent into a product that consumers can enjoy.

Of course, the public-goods and commercialization-incentive narratives will not always hold true. Nor will patents always be the driver of invention. First-mover advantage, Darwinian survival against advancing rivals, network effects, an ability independent of IP rights to protect a developed technology against copying, a desire to foster name recognition or reputation, and a host of other factors can spur innovation. In some settings, one would expect them to be a more powerful impetus toward innovation than patents. Yet, there is no reason to think that non-patent factors spurring innovation are so ubiquitous and powerful as to render patents superfluous always and everywhere. Indeed, survey evidence shows that patents are indispensable for innovation in some industries and still relevant as secondary appropriation mechanisms elsewhere.[269] Competition, rivals' difficulty in copying, and lag time will not instill sufficient incentives in some markets, especially those where the ratio of cost of invention to cost of copying is high or where commercialization costs are acute.[270] In those settings, patents may serve a critical function in instilling otherwise-insufficient incentives to devote capital to R&D.

Although there are strong reasons in theory to expect that patents will spur innovation, the economic literature also warns that improperly calibrated patent rights can hinder technical advance.[271] As to a standalone invention, expanding patent scope allows the inventor to extract a greater proportion of the technology's social value, making it a more inviting R&D prospect in which to invest, but increasing the deadweight loss imposed by patent protection over a valuable technology for which no good substitutes exist.[272] In many settings, however, it is a mistake to look at one invention divorced from its larger context. Heavily cumulative innovation is the norm in some industries, such as software. There, expanding patent scope may not only increase the static inefficiencies of monopoly pricing, but restrict follow-on R&D efforts. Hence, economic theory teaches that optimal patent scope requires careful regard for the idiosyncrasies of the innovation setting in which it arises. Nevertheless, the economic literature

269. *See supra* Part III.C.1.c.

270. *Id.*

271. *See, e.g.*, Merges & Nelson, *supra* note 8, *passim*.

272. *Id.*

does not suggest that patent protection is wholly inappropriate in cumulative-innovation environments.

It is important to evaluate that theory in the context of a long-running U.S. innovation platform in which private industry has invested vast sums in reliance on the patent system and produced a stunning array of innovative technologies. Given this history, in my view, the economic rationale for patents is convincing and the notion that patents cripple innovation is strongly counterintuitive. Bringing rudimentary principles of decision theory to bear on questions of patent policy — in particular, the need to avoid false positives such as erroneously diluting patent rights that actually promote innovation — it follows that responsible policymakers should be reluctant to diminish IP rights.

With those considerations in mind, to justify a significant departure from the status quo, I would require evidence that patents suppress U.S. innovation. In some commentators' views, the econometric literature fails to prove that patents enhance social welfare by spurring R&D to a degree that outweighs deadweight loss and restrictions on follow-on innovation.[273] That analytic approach is off the mark. Instead, one must consider that we approach the patent-design question not from a platform that lacks patent rights, but from one in which they feature prominently. To justify a move from the current framework, which underpins the illustrious track record of U.S. innovation, a reasonable question is whether the evidence suggests that it is more likely than not that the net effect of patents is to suppress current levels of innovation. Such evidence is lacking. To the contrary, the empirical literature yields insights that should give patent skeptics pause in making their case.

Part II's review of econometric studies demonstrated several findings. Patents exhibit consistent and statistically significant correlation with private R&D investment and with economic growth, at least in developed countries. It is difficult to overstate the importance of those findings. Although it is precarious to ascribe causal significance to such a statistical relationship, it is certainly important that there is an evident association between robust patent protection, R&D expenditures, and growth. Policymakers should thus be very cautious before concluding that the government could safely disregard, abolish, or dilute patents in that setting. Reviewing the literature, the worst that can be said is that empirical studies of nations that strengthened patents rights do not always find a corresponding rise in innovation. Yet, those studies found no evidence that magnifying the strength of patent protection reduced private-sector R&D or innovation. To the contrary, survey evidence reveals that patents are critical to inventions in the

273. *See supra* Part II.A.

life sciences industry and in some others. Elsewhere, patents play a secondary role to other factors that encourage innovation, but that does not make them irrelevant. There is also evidence that patents facilitate technology transfer and are important to startups that seek venture capital funding.[274]

Those who favor patent abolition may strive to explain away correlations between patent strength and R&D. Because correlation does not imply causation, they may disregard the abundant evidence identifying a statistical relationship between patents and both R&D and economic growth. Also, evidence that patents are a but-for cause of innovation in important sectors of the economy may carry little weight for some commentators because government subsidies or alternative reward systems could recreate the full panoply of patent-generated incentives. They may also argue that if patents are not the principal driver of innovation in other industries, taking them away should not materially affect the bottom line.

Such interpretations of the evidence are unconvincing and strain to resolve every ambiguity against the proposition that the theorized relationship between robust patent rights and innovation is sound. More importantly, they do not provide a sound foundation for policy-making in this increasingly important part of the U.S. economy.

Those inclined to restrict or even remove patent rights face an important consideration independent of the question of whether the patent system's net effect is to advance or inhibit technological advance. Specifically, there is ample evidence that firms respond to adjustments to the patent system. Even industries that enjoy anti-appropriation mechanisms more effective than patents invest heavily in patents — if only to secure a strategic market position or otherwise facilitate commercialization or entry. Abolishing or seriously weakening the patent system would be extremely disruptive, imposing stranded costs that would almost certainly yield a net negative effect on R&D investment in the short run. Such a sweeping transformation of the new economy would change the kinds of inventions and technologies that markets would produce. Certainly, firms would direct their R&D away from easily appropriable technologies and toward those susceptible to trade-secret protection. Ultimately, there is little or no empirical basis to support the proposition that any long-term pro-innovative advantages stemming from a major loosening of patent rights would outweigh the short-run costs, which would likely be severe.

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274. It is also possible that patents serve a material role in disclosing useful technologies, though it is unclear whether most patents effectively perform that function. Daniel J. Hemel & Lisa Larrimore Ouellette, *Knowledge Goods and Nation-States*, 101 Minn L. Rev. 167 (May 1, 2016), http://ssrn.com/abstract=2745632.

With such high stakes, it is clear that any analysis by policymakers should feature error costs prominently. It is true that the empirical evidence to date remains incomplete about the precise circumstances in which incremental strengthening of patent rights enhances or hurts innovation. What we do know, however, is that the U.S. innovation system is an extraordinary success story and the envy of the world. For better or for worse, patents have always played a central role in America's innovation platform. Today, it is impossible to ignore that the industries in which critics accuse patents of playing the most damaging role — smartphones, semiconductors, and computer software — are among the most innovative of all U.S. industries.[275] They have achieved their unsurpassed technological progress within a setting of myriad patents. Whether that success is because of patents or notwithstanding them is a difficult question to answer. Certainly, one could argue that innovation would have been even greater without the claimed suppressive effect of patents. Resolving that claim requires proving a counterfactual. In the face of a system that works well, one should evaluate claims that a component of that system is seriously broken with a healthy dose of skepticism. Instead, those advocating serious patent dilution or abolition should present convincing evidence that patents have indeed suppressed innovation in that setting. Such evidence remains elusive, however.

In short, I find that the U.S. innovation experience, theory, and econometric work combined are a powerful argument against abandoning or compromising the patent system. The focus instead should be on recalibration. Lawmakers should enhance quality, boost the clarity of patent disclosure, ratchet up obviousness and novelty conditions in industries subject to anticommons and royalty-stacking effects, encourage breakthrough technologies through suitable rights over pioneer inventions, and narrow patent scope in heavily cumulative fields of innovation that are subject to high transaction costs. The literature to date suggests that such tailored reforms are likely to boost innovation. Similarly, the law should suppress abuse of the patent system, rather than undertake its abolition.

V. CONCLUSION

The patent system has been part of the fabric of this country since its founding. Enjoying constitutional recognition, patents reflect American ideals of entrepreneurship, creative genius, moral desert, and private ownership rights. To this day, people associate patents with famous inventors like Benjamin Franklin, Thomas Edison, Alexander Graham Bell, Samuel Morse, and the Wright Brothers. That

275. *See, e.g.*, *Reply Submission*, *supra* note 1, at 3.

exalted role coincides today with an era of unprecedented technological advance. The last thirty years alone have seen explosive innovation in high-speed computing, the Internet, information technology, consumer electronics, medical technology, hybrid fuels, aviation and car design, and more besides. By any metric, the U.S. economy has been the foremost contributor to this scientific progress. Today's groundbreaking innovators are disproportionately American. Companies like Apple, Google, IBM, Microsoft, Facebook, Uber, Tesla, General Electric, and Amazon blaze paths into the future. Many of those firms apply for, and receive, thousands of U.S. patents annually.

What makes the U.S. economy such a compelling incubator of future technology? The answer lies in an exceptional innovation policy, which combines myriad factors to create an environment conducive to effective R&D. Political stability, property rights, competitive markets, a culture that rewards and celebrates ingenuity, bankruptcy laws tailored to spur calculated risk-taking, a disproportionate share of the world's best universities, a strong economy with venture capital to fund promising ideas, employment laws that promote the free movement of labor, and respect for the rule of law make the U.S. economy a bastion of invention without equal. A pillar of that innovation platform is the patent regime, which is operating at a busier clip today than in the past.[276] America goes further than perhaps any other jurisdiction to protect private ownership rights against appropriation — indeed, so much so that rights in one's property are arguably a defining hallmark of the U.S. legal tradition.

Those observations contextualize a crucial debate presently under way concerning the future of the U.S. patent system. Today, patents are under sustained attack for reasons that are variously justified and not. Certainly, the role that patents play in technology industries continues to evolve as the nature of the relevant technologies themselves change, and it is not surprising that policymakers may need to fine-tune an IP rights system in response. More alarming are broad attacks on the justifications for the patent system as a whole. Many technology users and some innovators are pouring cold water on the economic rationale for patents' social purpose. Some economists even argue that the government should abolish the patent regime in its entirety. The result has been acerbic debate, much of it reflecting articles of faith about patents' economic effects in promoting or suppressing the conception and marketing of technology. Predictably, stakeholders pro-

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276. World Intellectual Property Organization, *Global Patent Applications Rose to 2.9 Million in 2015 on Strong Growth from China; Demand Also Increased for Other Intellectual Property Rights* (Nov. 23, 2016), http://www.wipo.int/pressroom/en/articles/2016/article_0017.html; U.S. Patent and Trademark Office, *U.S. Patent Statistics Chart; Calendar Years 1963-2015*, (last visited Dec. 8, 2016), https://www.uspto.gov/web/offices/ac/ido/oeip/taf/us_stat.htm.

mote their respective constituencies' private interests. As patent law generally applies one-size-fits-all rules across the full array of private industries, it is inevitable that provisions that benefit some economic actors will hinder others.

Patents are not always the principal spurring force for all inventions all the time. But there is ample evidence supporting the basic but powerful intuition underlying the patent system. Thus, some critics' claim that contemporary patent policy lacks an evidentiary foundation does not hold up upon deeper examination. As is true in many areas of life, the real picture is variously messy, complex, qualified, and ambiguous. Yet the stakes are immense, meaning that we must grapple with the facts as we can best discern them in effecting policy. The responsible reaction to the various strengths and weaknesses of the contemporary patent system lies in incremental adjustment. Patents should remain a cornerstone of effective innovation policy.