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The Debilitating Effect of Exclusive Rights: Patents and Productive Inefficiency

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THE DEBILITATING EFFECT OF EXCLUSIVE RIGHTS: PATENTS AND PRODUCTIVE INEFFICIENCY

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Abstract

Are we underestimating the costs of patent protection? Scholars have long recognized that patent law is a double-edged sword. While patents promote innovation, they also limit the number of people who can benefit from new inventions. In the past, policy makers striving to balance the costs and benefits of patents have analyzed patent law through the lens of traditional, neoclassical economics. This Article argues that this approach is fundamentally flawed because traditional economics rely on an inaccurate oversimplification: that individuals and firms always maximize profits. In actuality, so-called "productive inefficiencies" often prevent profit maximization. For example, cognitive biases, bounded rationality, habituation, and opportunism all contribute to productive inefficiencies that harm individuals, firms, and ultimately society. Moreover, a variety of theoretical analyses and empirical studies demonstrate that robust competition reduces productive inefficiencies. Consequently, patents that substantially limit competition exacerbate productive inefficiencies and an important effect of patent law therefore has been systematically overlooked. This Article begins to fill this void and demonstrates that consideration of productive inefficiencies sheds new light on numerous unresolved and contentious debates in patent law.

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"The best of all monopoly profits is a quiet life."
Nobel Laureate J.R. Hicks (1935)[1]

INTRODUCTION

The pharmaceutical industry is one of the most innovative sectors of the U.S. economy. Every year, pharmaceutical companies invest tens of billions of dollars in research and development discovering new drugs.[2] Many of these discoveries are protected with patents and even some critics of patent law concede that pharmaceutical patents generally promote the discovery of new drugs.[3] But the innovative successes of pharmaceutical companies may conceal puzzling failures. According to some commentators, pharmaceutical companies have failed to adopt modern manufacturing techniques that are common in other industries; as a result,

1. J. R. Hicks, *Annual Survey of Economic Theory: The Theory of Monopoly*, 3 ECONOMETRICA 1, 8 (1935).

2. PHRMA, 2013 PROFILE: BIOPHARMACEUTICAL RESEARCH INDUSTRY 31 (2013), http://www.phrma.org/sites/default/files/pdf/PhRMA%20Profile%202013.pdf.

3. *See, e.g.*, JAMES BESSEN & MICHAEL J. MEURER, PATENT FAILURE: HOW JUDGES, BUREAUCRATS, AND LAWYERS PUT INNOVATION AT RISK 106 (2008) (noting that "managers in the pharmaceutical and chemical industries consider[] patents as essential to developing and marketing 30 percent or more of inventions").

pharmaceutical manufacturing is comparatively slow, expensive, and error-prone.[4] Manufacturing mediocrity in the pharmaceutical industry is particularly surprising because even modest improvements could substantially increase profits.[5] In fact, pharmaceutical companies spend more on manufacturing than they do on research and development.[6]

How could pharmaceutical companies be so good at the difficult task of discovering new drugs but so bad at the comparatively easy task of embracing modern manufacturing techniques? Although many factors affect drug manufacturing,[7] this Article identifies an overlooked and unlikely culprit: strong pharmaceutical patents. Moreover, this Article argues that the subpar manufacturing of medicines not only undercuts the profits of pharmaceutical companies but also reduces welfare for all of society.

Without a doubt, innovation produces massive social benefits. Through technological improvements many people today live longer, healthier, more productive lives.[8] Patents can be a key driver of socially beneficial innovation. Discovering new inventions often requires substantial time, effort, and capital, and patents encourage inventors and businesses to invest in research and development by providing inventors with exclusive rights to their discoveries.[9] Unfortunately, although patents have great

4. W. Nicholson Price II, *Making Do in Making Drugs: Innovation Policy and Pharmaceutical Manufacturing*, 55 B.C. L. REV. 491, 500 (2014) (arguing that "[p]harmaceutical manufacturing has lagged far behind other industries in adopting modern manufacturing techniques").

5. *Id*. at 504 ("Tens of billions of dollars are spent annually on [pharmaceutical] manufacturing inefficiencies. Efficiency increases consequently carry large potential benefits."); *see* Richard A. Posner, *Natural Monopoly and Its Regulation*, 21 STAN. L. REV. 548, 574 (1969) (noting that "[c]ost reduction will enable the monopolist to increase its profits").

6. Price, *supra* note 4, at 497 & n.39 (stating that for pharmaceutical companies "[m]anufacturing is either the largest or secondlargest expense" behind sales and marketing).

7. *See, e.g.*, *id.* at 510–12 (arguing that regulatory hurdles and insufficient patent protection undermine incentives to develop improved manufacturing processes in the pharmaceutical industry).

8. Indeed, the U.S. Department of Commerce estimates that innovation produced almost 75% of the growth in the U.S. economy since World War II. ARTI RAI ET AL., U.S. DEP'T OF COMMERCE, PATENT REFORM: UNLEASHING INNOVATION, PROMOTING ECONOMIC GROWTH & PRODUCING HIGH-PAYING JOBS 2 (2010), *available at* http://www.commerce.gov/sites/default/files/documents/migrated/Patent_Reform-paper.pdf. Other estimates are lower, but are still significant. *See* COUNCIL ON COMPETITIVENESS, INNOVATE AMERICA 36 (2005), *available at* http://www.compete.org/publications/detail/202/innovate-america/ (noting that innovation generates productivity that has accounted for approximately half of U.S. GDP growth over the past fifty years); *see also* JUDY ESTRIN, CLOSING THE INNOVATION GAP: REIGNITING THE SPARK OF CREATIVITY IN A GLOBAL ECONOMY 142 (2009), *available at* http://www.books24x7.com/marc.asp?bookid=29867 ("The growth of the U.S. economy has become dependent on the small, innovative companies that have thrived for decades in places like Silicon Valley."). However, not all patented inventions produce commercially successful innovations. *See infra* Section III.C.

9. For citations regarding the incentive benefits of patent rights, see *infra* note 51.

capacity to benefit society, they can also reduce social welfare. For example, owners of exclusive patent rights sometimes raise the costs of products and services that incorporate new inventions and some customers may be unable to afford these higher prices as a result.[10] Furthermore, patent owners can use their rights to obstruct technological progress by preventing others from building upon their patented inventions.[11]

Balancing costs and benefits is thus vital to the development of effective patent laws, and lawmakers strive to calibrate this trade-off by adjusting the contours of patent rights.[12] Unfortunately, empirically measuring the full costs and benefits of patent law is infeasible (if not impossible) and this prevents a mathematical optimization.[13] Instead, numerous government entities, including Congress, the courts, and the U.S. Patent and Trademark Office, define the contours of patent law through their activities and interactions.[14] In this process, the identification of *which* costs and benefits stem from patent protection is critical. If

10. *See, e.g.*, Ass'n for Molecular Pathology v. Myriad Genetics, Inc., 133 S. Ct. 2107, 2113 (2013) (noting that certain "patents would, if valid, give [the owner of the patents] the exclusive right" to perform certain medical tests).

11. *See* Robert P. Merges & Richard R. Nelson, *On the Complex Economics of Patent Scope*, 90 COLUM. L. REV. 839, 843 (1990) (noting the social costs of patents, which include reduction of competition).

12. *See* WILLIAM M. LANDES & RICHARD A. POSNER, THE ECONOMIC STRUCTURE OF INTELLECTUAL PROPERTY LAW 21 (2003) (discussing patent law's purported design to achieve a cost–benefit trade-off).

13. *See id*. at 9 ("The economic case for abolishing intellectual property rights has not been made. But neither economic theory nor empirical evidence enables a ringing endorsement of any complete body of [patents or copyrights]."); William Hubbard, *The Competitive Advantage of Weak Patents*, 54 B.C. L. REV. 1909, 1934 (2013); Peter Lee, *Toward a Distributive Commons in Patent Law*, 2009 WIS. L. REV. 917, 931 (asserting that "the patent system does not engage, nor is it equipped to engage, in macroscopic cost-benefit analyses to determine the ideal scope of particular exclusive rights"); Margaret Jane Radin, *Regulation by Contract, Regulation by Machine*, 160 J. INSTITUTIONAL & THEORETICAL ECON. 1, 7 (2004) ("How much propertization is too much? That is an empirical question to which no one knows the answer."). Economist Fritz Machlup famously concluded his study of the U.S. patent system, unsure of the system's social utility, with the following:

> If we did not have a patent system, it would be irresponsible, on the basis of our present knowledge of its economic consequences, to recommend instituting one. But since we have had a patent system for a long time, it would be irresponsible, on the basis of our present knowledge, to recommend abolishing it.

STAFF OF S. COMM. ON THE JUDICIARY, 85TH CONG., AN ECONOMIC REVIEW OF THE PATENT SYSTEM 80 (Comm. Print 1958).

14. *See* Shubha Ghosh & Jay Kesan, *What Do Patents Purchase? In Search of Optimal Ignorance in the Patent Office*, 40 HOUS. L. REV. 1219, 1251–53 (2004) (noting the relationship between Congress and the U.S. Patent and Trademark Office); J. Jonas Anderson, *Patent Dialogue*, 92 N.C. L. REV. (forthcoming 2014) (manuscript at 2), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2402352 (discussing the "patent dialogue" between the branches of the federal government).

lawmakers, judges, and scholars systematically overlook substantial costs or benefits from patent law, the patent system in the United States cannot operate effectively. As the Nobel Prize winning economist Oliver Williamson observed, "analysis influences the way the world is perceived, including the power to delude and misguide as well as to illuminate and instruct."[15]

Today, traditional or "neoclassical" economics constitute the dominant approach to identifying the costs and benefits of patent law. Under this approach, patent rights benefit society by creating economic incentives to discover, disclose, and commercialize new inventions but harm society by allowing firms to raise prices above competitive levels.[16] In describing these costs and benefits, neoclassical economics is grounded on the assumption that individuals and firms maximize profits.[17] As a result, the argument goes, when patent law is properly calibrated, the "invisible hand" of the market will typically prompt self-interested firms to make decisions that ultimately maximize social welfare.[18]

Although many economists embrace the profit-maximization assumption, a growing group of economists does not.[19] For example,

15. OLIVER E. WILLIAMSON, MARKETS AND HIERARCHIES: ANALYSIS AND ANTITRUST IMPLICATIONS 249 (1975); *see also* Christopher Buccafusco & Christopher Sprigman, *Valuing Intellectual Property: An Experiment*, 96 CORNELL L. REV. 1, 6 (2010) (asserting that "the abstract level of economic thinking . . . drives most intellectual property policymaking"); Dennis D. Crouch, *The Patent Lottery: Exploiting Behavioral Economics for the Common Good*, 16 GEO. MASON L. REV. 141, 141–42 (2008) ("Policymakers' understanding of both the upside and downside of patent protection is important so they can better calibrate the rights granted: making them strong enough to help induce innovation and development while limiting monopolistic problems.").

16. *See infra* Section I.A.

17. *See* ROGER S. FRANTZ, X-EFFICIENCY: THEORY, EVIDENCE, AND APPLICATIONS 63 (1988) ("The neoclassical assumption of rationality was applied in such a way as to make the production process seem like a mechanical process and for the firm to be nothing other than an efficient converter of inputs into their maximum outputs."); HARVEY LEIBENSTEIN, GENERAL X-EFFICIENCY THEORY AND ECONOMIC DEVELOPMENT 9 (1978) ("Let us recall that according to the neoclassical theory all of the options are known and the prices of inputs and outputs are also known."); N. GREGORY MANKIW, PRINCIPLES OF MICROECONOMICS 282–88 (6th ed. 2012) ("The goal of a competitive firm is to maximize profit . . . ."); WILLIAMSON, *supra* note 15, at 250 (noting that standard economic theory "assume[s] that the firm operates on its production function, which shows the maximum output of product that can be realized from each feasible combination of factor inputs"); Buccafusco & Sprigman, *supra* note 15, at 2; Harry S. Gerla, *Restoring Rivalry as a Central Concept in Antitrust Law*, 75 NEB. L. REV. 209, 224 (1996) (noting that the basic operating assumption under modern neoclassical economics is that "firms always seek to maximize their profits").

18. *See* MANKIW, *supra* note 17, at 11 ("[D]espite decentralized decision making and self-interested decision makers, market economies have proven remarkably successful in organizing economic activity to promote overall economic well-being.").

19. According to one economist, "the hypothesis of profit maximization has mutated into an axiom." RICHARD E. CAVES, INDUSTRIAL EFFICIENCY IN SIX NATIONS 1 (1992); *see also* RICHARD E. CAVES & DAVID R. BARTON, EFFICIENCY IN U.S. MANUFACTURING INDUSTRIES 1 (1990) ("[S]ome economists declare [productive] inefficiency to lie outside the reach of analytically founded

numerous economists assert that individuals do not maximize profits due to cognitive biases, limited cognitive capacities, and bad habits.[20] Others have demonstrated that conflicts between principals and agents can prevent firms from maximizing their profits.[21] All of these economists agree that inherent features of human behavior and interpersonal interaction often prevent individuals and firms from maximizing their profits. Moreover, such failure to maximize profits reduces social welfare.[22] However, this harm to society is not inevitable. Modern economists argue on both theoretical and empirical grounds that competition drives individuals and firms toward profit maximization and thus increases social welfare.[23] Despite the importance of this economic scholarship, it is unfortunately fragmented and widely dispersed. Some economists focus only on individual obstacles to profit maximization and only analyze the effects of competition in passing.[24] Though other economists provide more fulsome analyses, they also employ different terminology to describe circumstances that prevent firms from maximizing their own profits, including "internal inefficiency,"[25] "organizational slack,"[26] "productive inefficiency,"[27] "technical inefficiency,"[28] and "X-inefficiency."[29]

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economic analysis because the manager of an inefficient activity is failing to maximize its profits, and the maximization of profits by the business is taken as equivalent to the maximization of utility by the individual, a largely unquestioned axiom of economic analysis.").

20. *See* FRANTZ, *supra* note 17, at 67–68; HERBERT A. SIMON, MODELS OF MAN: SOCIAL AND RATIONAL 198 (1957); RICHARD H. THALER & CASS R. SUNSTEIN, NUDGE: IMPROVING DECISIONS ABOUT HEALTH, WEALTH, AND HAPPINESS 22–39 (2008) (discussing cognitive bias); WILLIAMSON, *supra* note 15, at 21 (describing"bounded rationality"); David Michael Jaros, *Perfecting Criminal Markets*, 112 COLUM. L. REV. 1947, 1979–80 (2012) (describing various cognitive biases).

21. *See, e.g.*, WILLIAMSON, *supra* note 15, at 26–30 (discussing employees' opportunistic use of asymmetrical information); Robert P. Merges, *The Law and Economics of Employee Inventions*, 13 HARV. J.L. & TECH. 1, 26–30 (1999) (discussing principal–agent problems in the context of the employee–inventor).

22. *See infra* Section II.B.

23. *See infra* Subsection II.C.1.

24. *See, e.g.*, SIMON, *supra* note 20, at 198 (discussing "bounded rationality," which posits that the capacity of the human mind is limited relative to the complex problems facing humans); THALER & SUNSTEIN, *supra* note 20, at 22–39 (discussing cognitive biases).

25. Posner, *supra* note 5, at 573.

26. F. M. SCHERER, INDUSTRIAL MARKET STRUCTURE AND ECONOMIC PERFORMANCE 35 (2d ed. 1980); *see also* Richard Gilbert, *Looking for Mr. Schumpeter: Where Are We in the Competition-Innovation Debate?*, *in* 6 INNOVATION POL'Y & ECON. 159, 179 (2006), *available at* http://www.nber.org/chapters/c0208.pdf.

27. CAVES, *supra* note 19, at 1; *cf.* Robert H. Lande, *Wealth Transfers as the Original and Primary Concern of Antitrust: The Efficiency Interpretation Challenged*, 34 HASTINGS L.J. 65, 78 (1982) ("Whereas allocative efficiency concerns overall placement of resources in the economy, productive, or technical, efficiency refers to individual firms' use of their resources in the most effective manner.").

28. CAVES, *supra* note 19, at 1; CAVES & BARTON, *supra* note 19, at 2; Alison Green & David Mayes, *Technical Inefficiency in Manufacturing Industries*, 101 ECON. J. 523, 524 (1991), *available at* http://econpapers.repec.org/article/ecjeconjl/default1991.htm ("Technical inefficiency

Perhaps because of this multiplicity of approaches to these issues in the economic literature, patent scholars have largely ignored the ramifications of these economic insights on the design of effective legal systems.[30] In the words of two prominent scholars, "[intellectual property], perhaps more than any other substantive area of law, is grounded in the rational actor model that undergirds classical economics."[31] Only a small group of patent scholars have applied a broader economic perspective to patent law, and these scholars have limited their analyses to specific contexts, such as the effects of cognitive biases on inventors and judges.[32] Patent law scholars thus have not recognized that firms and individuals often do not maximize their profits and that this overlooked economic insight contradicts fundamental assumptions lying at the heart of current patent policy.

This Article begins to fill this void in the literature regarding the economic effects of patent law. To start, this Article collects, unifies, and

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is thus the failure to achieve maximum possible output from whatever combination of inputs have been chosen.").

29. FRANTZ, *supra* note 17, at 194; LEIBENSTEIN, *supra* note 17 at 104–06; *see also* CAVES & BARTON, *supra* note 19, at 2 (discussing X-inefficiency and technical inefficiency).

30. *See* LANDES & POSNER, *supra* note 12, at 11 (asserting that there is "a tendency among economic analysts of intellectual property to reduce the entire problem of intellectual property rights to a tradeoff between 'incentive[s]' [to create] and 'access' [to those creations]"); Buccafusco & Sprigman, *supra* note 15, at 2 (noting that "there has been relatively little discussion of [modern economic theories'] implications for intellectual property (IP) law"). For a more detailed account of the conventional economic view of patent scholars, see *infra* notes 51, 54, 60, and 65 and accompanying text. In other areas of law, particularly in antitrust law, scholars have better engaged modern economic perspectives. *See, e.g.*, David W. Barnes, *Nonefficiency Goals in the Antitrust Law of Mergers*, 30 WM. & MARY L. REV. 787, 798–99 (1989) (discussing productive inefficiency in the context of antitrust law); Gerla, *supra* note 17, at 223–28 (discussing productive inefficiency under the label "X-inefficiency" in the context of antitrust law); Joshua D. Wright & Judd E. Stone II, *Misbehavioral Economics: The Case Against Behavioral Antitrust*, 33 CARDOZO L. REV. 1517, 1517–18 (2012) (arguing that considerations of behavioral economics should not affect antitrust law and critiquing the behavioralist approach).

31. Buccafusco & Sprigman, *supra* note 15, at 3.

32. *E.g.*, *id.* at 4 (arguing that the "endowment effect" may undermine the transfer of intellectual property rights); Crouch, *supra* note 15, at 161 (arguing that "bounded rationality" affects inventors' decisions to seek patent protection); Ghosh & Kesan, *supra* note 14, at 1248–50 (arguing that the U.S. Patent and Trademark Office issues invalid patents in part because patent examiners are boundedly rational); Michael A. Heller & Rebecca S. Eisenberg, *Can Patents Deter Innovation? The Anticommons in Biomedical Research*, 280 SCI. 698, 701 (1998), *available at* http://www.cornellcollege.edu/dimensions/workshops/reading-group-resources/science-280.pdf (asserting that the "'attribution bias"' hinders patent licensing); Gregory N. Mandel, *Patently Non-Obvious: Empirical Demonstration that the Hindsight Bias Renders Patent Decisions Irrational*, 67 OHIO ST. L.J. 1391, 1411–20 (2006) (arguing that hindsight bias affects whether decision makers find that patents are obvious in light of the prior art); R. Polk Wagner, *Understanding Patent-Quality Mechanisms*, 157 U. PA. L. REV. 2135, 2155–56 (2009) (asserting that cognitive biases will prompt inventors to seek patents that are not cost-justified). Broader applications of modern economic analyses to patent law are exceedingly rare. *See, e.g.*, Liza Vertinsky, *An Organizational Approach to the Design of Patent Law*, 13 MINN. J.L. SCI. & TECH. 211, 214 (2012) (applying the insights of new institutional economics to patent policy).

harmonizes much of the economic scholarship analyzing obstacles to profit maximization, beginning by adopting the single term "productive inefficiency" to describe any situation in which individuals or firms fail to maximize their own profits. Building from the existing economic literature, this Article argues that competition generally improves productive efficiency. Using these economic insights, this Article argues that traditional economic analyses of patent law fail to correctly assess the costs and benefits stemming from patent protection because patent rights that restrain competition can undermine profit maximization. As a result, firms will not respond to financial inducements to invent in the ways predicted by neoclassical economics.[33] For instance, pharmaceutical firms may tolerate outdated manufacturing technologies and processes *because* powerful patents protect their products.

This Article proceeds in three Parts. Part I begins by describing in more detail the traditional neoclassical economic model and its use by patent scholars. Part I establishes that patent scholars typically rely upon neoclassical economics to identify and analyze the costs and benefits of patent law in order to increase social welfare. Part II then synthesizes the substantial economic literature rejecting the neoclassical assumption of profit maximization and identifying numerous factors that limit the productive efficiency of individuals and firms. Part II also details the harms to society caused by productive inefficiencies and the economic mechanisms to reduce those harms. In particular, Part II argues that competition reduces productive inefficiencies. Part III applies this more fulsome economic perspective to patent law in general, as well as to three unresolved debates in patent law regarding the commercialization of patented inventions, patent scope, and patent examination. Finally, the Conclusion provides a brief summary of the main arguments in this Article.

I. NEOCLASSICAL ECONOMICS AND PATENT LAW

Most legal scholars rely on traditional neoclassical economics to analyze the effects of patent law, and thus, a clear understanding of this model is required to appreciate the role that neoclassical economics plays in patent law scholarship.

A. *Neoclassical Economics*

Neoclassical economics is founded on the assumption that individuals and firms minimize costs and maximize profits.[34] Economist Oliver Williamson has described this assumption in more detail:

33. *See infra* Section I.A.

34. *See supra* note 17 and accompanying text.

> [I]t is assumed that the firm operates on its production function, which shows the maximum output of product that can be realized from each feasible combination of factor inputs (mainly labor and capital). Failure to operate on the production function would imply wasteful use of inputs; this is assumed away.[35]

Importantly, this assumption generates one of the most important conclusions of neoclassical economics: that competitive markets typically maximize social welfare.[36] To maximize profits, firms must compete with their rivals, and this competition drives prices down. Lower prices allow for more transactions to be completed and each successful transaction benefits consumers.[37] For example, when a consumer is willing to pay $10 to purchase a product but is able to purchase it at a market price of only $7, the consumer enjoys a benefit of $3. Economists call such a benefit from trade to a consumer a "consumer surplus."[38] Similarly, if the manufacturer of the product is willing to sell it for $5, then the sale at a price of $7 also creates a "producer surplus" of $2.[39] Neoclassical economists argue that competitive markets reach an equilibrium that maximizes social welfare because competition drives prices down to a level that supports the maximum number of socially beneficial transactions, thereby maximizing the total consumer and producer surpluses.[40]

Although market transactions generate social wealth, neoclassical economics recognizes that they may fail to take place in (at least) two canonical situations. First, a monopolist may strategically decide to engage in only certain transactions by raising prices (or as economists prefer to phrase it, restrict output so that prices rise due to consumer demand).[41] Some consumers will be unable to afford the higher price, and some socially beneficial transactions therefore will not take place resulting in the loss of some of the total surplus. Economists refer to this loss as

35. WILLIAMSON, *supra* note 15, at 250.

36. *See* MANKIW, *supra* note 17, at 11.

37. *Id.* at 136–41 (discussing the economic principle of consumer surplus).

38. The consumer surplus is defined as the difference between the amount a consumer is willing to pay for a good or service and the price that the consumer actually pays for it. *Id.* at 137.

39. Specifically, a producer surplus is the difference between the price that a producer charges and the producer's valuation of the good or service. *Id.* at 141. Because profit-maximizing firms will not sell if their costs exceed their financial returns, neoclassical economics concludes that each transaction generates a producer surplus.

40. *Id.* at 136, 145–46 (describing total surplus).

41. *See* MANKIW, *supra* note 17, at 212 (discussing the problems that transaction costs and externalities have on reaching an efficient bargain); *id.* at 306–07 (discussing profit maximization vis-à-vis monopolization).

"deadweight loss" and this situation as "allocative inefficiency."[42] Although the monopolist also suffers from the deadweight losses by sacrificing some of its producer surplus, the monopolist more than makes up for these losses through higher prices paid by consumers who can still afford the goods or services. Although profit maximization by the monopolist can reduce social welfare,[43] the monopolist's desire to maximize profits limits the harm to social welfare by preventing the monopolist from raising prices to even higher levels. According to neoclassical economic analysis, the monopolist will raise prices until its marginal costs equal its marginal revenues but no further.[44]

A second scenario in which market transactions do not take place is when transaction costs prevent producers and consumers from consummating transactions.[45] As economist Ronald Coase famously argued, if transactions are costless to consummate, individuals will voluntarily agree to exchanges that increase both individual and social welfare.[46] In reality, however, transaction costs are often substantial and thus "prevent many transactions that would be carried out in a world in which the pricing system worked without cost."[47] When transaction costs are nontrivial, markets may fail to maximize social welfare.[48]

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42. *See* FRANTZ, *supra* note 17, at 2–3; *id.* at 21 ("The costs of monopoly power are thus relatively high prices for lower than desired output rates and a distortion in the mix of goods from what consumers desire."); MANKIW, *supra* note 17, at 178.

43. Another effect of monopolies is wasteful '"rent seeking"'—"[e]conomic rent is a return over and above the cost of generating the return; it is pure profit, and so worth incurring costs to obtain, even if the costs exceed the social benefit from the undertaking, as they often do." LANDES & POSNER, *supra* note 12, at 17. In competing to obtain a monopoly, firms may spend wastefully. *Id.* at 16–18; *see also* Michael Abramowicz, *The Danger of Underdeveloped Patent Prospects*, 92 CORNELL L. REV. 1065, 1112 (2007) (noting that rent seeking often arises with efforts to capture "government largesse").

44. MANKIW, *supra* note 17, at 307 (positing that the "equality of marginal revenue and marginal cost determines the profit-maximizing quantity" for both competitive firms and monopolies).

45. LANDES & POSNER, *supra* note 12, at 16 (noting that if transaction costs are too high, "a property right may prevent optimal adjustments to changing values"); *see also* MANKIW, *supra* note 17, at 212.

46. *See* R. H. Coase, *The Problem of Social Cost*, 3 J.L. & ECON. 1, 6, 8 (1960); *accord* Guido Calabresi & A. Douglas Melamed, *Property Rules, Liability Rules, and Inalienability: One View of the Cathedral*, 85 HARV. L. REV. 1089, 1094 & n.12 (1972) ("Recently it has been argued that on certain assumptions, usually termed the absence of transaction costs, Pareto optimality or economic efficiency will occur regardless of the initial entitlement.").

47. Coase, *supra* note 46, at 15.

48. *See* Calabresi & Melamed, *supra* note 46, at 1106–09 ("Often the cost of establishing the value of an initial entitlement by negotiation is so great that *even though a transfer of the entitlement would benefit all concerned*, such a transfer will not occur." (emphasis added)). Although not the focus of this Article, markets also do not maximize social welfare when externalities prevent the price of a product from accurately reflecting the costs (or benefits) stemming from the product. MANKIW, *supra* note 17, at 197–202. In such a situation, market forces can promote the production of too much (or too little) of the product. *Id*. at 198–99. For example,

B. *Traditional Intellectual Property Scholarship*

Patent scholars recognize that patent laws affect market transactions and thus can harm society; scholars and policymakers therefore try to design legal regimes that maximize the extent to which the benefits of patent rights exceed the costs.[49] Traditional economics provides a framework for analyzing such benefits and costs and has become the dominant lens through which legal scholars evaluate the merits of patent law.[50]

Under this approach, the main benefit of patent rights is that they provide financial incentives for inventors to discover, disclose, and commercialize new inventions.[51] Building on the neoclassical assumption

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markets may produce an inefficiently large volume of a product when firms are not liable for the environmental damage caused by manufacturing the product. In such a situation, the firms that pollute are able to externalize some of the costs associated with a product. Forcing firms to internalize those costs will raise firms' marginal cost, thereby increasing both the market price for the good and overall social welfare.

49. *See, e.g.*, Louis Kaplow, *The Patent-Antitrust Intersection: A Reappraisal*, 97 HARV. L. REV. 1813, 1825 & n.29, 1826 (1984).

50. *See* LANDES & POSNER, *supra* note 12, at 4 ("Today it is acknowledged that analysis and evaluation of intellectual property law are appropriately conducted within an economic framework that seeks to align that law with the dictates of economic efficiency."). Some scholars, however, have offered less economically focused justifications for patents. *Id*. at 5 ("We are skeptical that the noneconomic theories of intellectual property have much explanatory power or normative significance . . . ."); *see, e.g.*, William Hubbard, *Inventing Norms*, 44 CONN. L. REV. 369, 371–73 (2011) (arguing that patents promote social norms that foster invention).

51. A complete recitation of the scholarship regarding the use of patents as incentives to discover, disclose, and commercialize inventions is impossible because the literature is enormous, but examples include the following: MICHELE BOLDRIN & DAVID K. LEVINE, AGAINST INTELLECTUAL MONOPOLY 158 (2008) (describing the traditional view of patent law); DAN L. BURK & MARK A. LEMLEY, THE PATENT CRISIS AND HOW THE COURTS CAN SOLVE IT 7 (2009) ("The idea behind the patent system is simple: invention is a 'public good' because it is expensive to invent but cheap to copy those inventions."); F. SCOTT KIEFF ET AL., PRINCIPLES OF PATENT LAW 64–68 (6th ed. 2013); ROBERT P. MERGES ET AL., INTELLECTUAL PROPERTY IN THE NEW TECHNOLOGICAL AGE 127 (4th ed. 2007) ("Patent law provides a market-driven incentive to invest in innovation, by allowing the inventor to appropriate the full economic rewards of her invention."); Dan L. Burk, *Patenting Transgenic Human Embryos: A Nonuse Cost Perspective*, 30 HOUS. L. REV. 1597, 1619–20 (1993); Lee, *supra* note 13, at 930 (noting certain trade-offs maintain "incentive[s] to invent"); Clarisa Long, *Patent Signals*, 69 U. CHI. L. REV. 625, 629 n.11 (2002) (collecting numerous citations to "literature modeling intellectual property in terms of rents and product markets," and stating that a complete list of such citations "would be impossible here"); Ted Sichelman, *Commercializing Patents*, 62 STAN. L. REV. 341, 357–58, 377 (2010) (describing the "reward" of exclusive patent rights as a "dominant justificatory theor[y] of patent law" that "largely motivates current patent doctrine"); Katherine J. Strandburg, *Users as Innovators: Implications for Patent Doctrine*, 79 U. COLO. L. REV. 467, 470 (2008) ("[D]iscussions of patent law and policy have for the most part remained rooted in the paradigm of commercial sale as motivation for invention, disclosure, and dissemination of technical advances"); Vertinsky, *supra* note 32, at 221–26. Although not the focus of the discussion of productive inefficiency in this Article, traditional scholars also recognize other benefits of patent rights. For example, some legal scholars contend that patent law creates

of profit maximization, legal scholars argue that an inventor will pursue patent rights at a level that effectively balances the costs and benefits borne by that individual in acquiring those rights.[52] As a result, changes in the value of patent rights such as a change in patent term will prompt inventors and their employers to adjust their behavior.[53]

Scholars have also relied on traditional economics to identify and analyze the costs stemming from exclusive patent rights and have divided these costs into three related categories. First and most importantly, many scholars focus their analyses on circumstances in which patent rights can disrupt the consummation of socially beneficial transactions. For example, patent scholars argue that exclusive patent rights can limit competition and allow firms to charge supra-competitive prices for their goods and services leading to allocative inefficiencies and deadweight losses.[54] Facing higher prices, some consumers will be unable to obtain goods or services that would be affordable in a competitive market, and these foregone transactions would have increased social welfare.[55] The costs to consumers from patent rights are sometimes substantial, such as when patents limit access to life-saving medical technologies. For example, by one estimate,

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information-related positive externalities. *See* Long, *supra*, at 628, 648 (arguing that patents provide a signaling mechanism to sources of capital that a patent owner, typically a business, engages in significant research and development). Similarly, others assert that patents provide information that help to support pro-innovation social norms. Hubbard, *supra* note 50, at 390–403.

52. *See, e.g.*, Long, *supra* note 51, at 630 (asserting that the conventional understanding of patent law posits that "[r]ational inventors will calculate the [potentially patentable] technology's expected revenue stream ex ante and proceed accordingly"). On the other hand, the lure of valuable patent rights may also encourage rent-seeking behavior. *See* Mark A. Lemley, *Property, Intellectual Property, and Free Riding*, 83 TEX. L. REV. 1031, 1058–60 (2005) ("[T]he prospect of intellectual property rights encourages rent-seeking behavior that is socially wasteful.").

53. LANDES & POSNER, *supra* note 12, at 21; *see also* Kaplow, *supra* note 49, at 1825–26 (noting the relationship between patent life and inventive activity).

54. Many scholars discuss the deadweight loss created by patents in consumer markets. *See, e.g.*, BURK & LEMLEY, *supra* note 51, at 8 (noting that patents "raise[] the cost of products to buyers" despite their incentive to inventors); Burk, *supra* note 51, at 1618 (arguing that patents *are designed* to create allocative inefficiencies); Alan L. Durham, *Patent Symmetry*, 87 B.U. L. REV. 969, 975 (2007) (asserting that deadweight loss will occur when consumers cannot afford a patent owner's supra-competitive prices); Lee, *supra* note 13, at 929 (asserting that in consumer markets patents "produce deadweight loss and may even facilitate monopolies that cause significant allocative distortions" (footnote omitted)); Mark A. Lemley, *The Economics of Improvement in Intellectual Property Law*, 75 TEX. L. REV. 989, 996–1000 (1997) (noting that because of an intellectual property right in a product, "fewer people will buy the [product] than if it were distributed on a competitive basis"); Long, *supra* note 51, at 632 (stating that patents "redistribut[e] consumer surplus to producers"); Merges & Nelson, *supra* note 11, at 871 ("[P]roprietary control of technology tend[s] to cause 'dead weight' costs due to restrictions on use."); David S. Olson, *Taking the Utilitarian Basis for Patent Law Seriously: The Case for Restricting Patentable Subject Matter*, 82 TEMP. L. REV. 181, 197 (2009) (same); Sichelman, *supra* note 51, at 358 & n.103 (same); Harry Surden, *Efficient Uncertainty in Patent Interpretation*, 68 WASH. & LEE L. REV. 1737, 1748–49 (2011) (same).

55. *See supra* notes 36–40 and accompanying text.

pharmaceuticals cost five to ten times more when protected by patents.[56]

Scholars also contend that exclusive patent rights create allocative inefficiencies and deadweight losses in technology markets because granting one entity the exclusive right to a discovery can prevent future innovators from building upon it.[57] Innovation is often a cumulative, evolutionary process and "some of the follow-on efforts of inventors could result in something not simply slightly different but significantly better than the patented technology."[58] In fact, because independent invention is not a defense to patent infringement,[59] patents can deter competitors from investing in innovation in patent-rich fields.

The second type of traditional economic cost that patent scholars frequently examine is the transaction cost related to the transfer of patent rights.[60] Indeed, the transfer of patent rights can actually prevent some of

56. BURK & LEMLEY, *supra* note 51, at 8. For more mundane consumer goods, however, the allocative inefficiency stemming from reduced transactions with consumers is often relatively small. F.M. Scherer, *Antitrust, Efficiency, and Progress*, 62 N.Y.U. L. REV. 998, 998–99 (1987).

57. Numerous scholars have examined the deadweight losses created by patents in technology markets. *See, e.g.*, BURK & LEMLEY, *supra* note 51, at 8 (asserting that patents "can not only encourage innovation, they can also interfere with it"); Burk, *supra* note 51, at 1618 ("[P]atents are likely to generate . . . inefficient allocation of resources."); Ghosh & Kesan, *supra* note 14, at 1237–38 (noting the detrimental impact of patents on the process of innovation); Lee, *supra* note 13, at 929–30 (stating that "many commentators have observed" that "patents also introduce dynamic distortions that may dampen follow-on innovation"); Lemley, *supra* note 54, at 996–1000; Long, *supra* note 51, at 632 (asserting that when inventions are patented "not enough information will be used"); Merges & Nelson, *supra* note 11, at 869–70; Sichelman, *supra* note 51, at 358 & n.103 (stating that patents "can stifle follow-on invention").

58. Merges & Nelson, *supra* note 11, at 869–70; *see* BURK & LEMLEY, *supra* note 51, at 8 ("A patent gives its owner a legal right . . . to stop independent inventors from continuing to use ideas they developed themselves."). At the same time, an over-abundance of patents can force competitors to engage in defensive patenting. For example, one competitor might obtain patents solely to be able to assert them in retaliation for patent claims by another competitor. Such patents can also be used to facilitate cross-licensing. 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 59–60 (2004) (describing the practice of cross-licensing between major companies); Mark A. Lemley, *Rational Ignorance at the Patent Office*, 95 NW. U. L. REV. 1495, 1505 (2001) (noting that "many companies obtain patents for reasons totally unrelated to litigation or licensing," including "patent[ing] broadly to 'hedge their bets' if they are uncertain which patents are likely to have value ex post").

59. BURK & LEMLEY, *supra* note 51, at 8.

60. A complete recitation of the scholarship discussing the transaction costs created by patents would be impractical here, but examples include: BESSEN & MEURER, *supra* note 3, at 140 (arguing that "by the late 1990s litigation costs clearly exceeded the profits from patents outside the chemical and pharmaceutical industries"); LANDES & POSNER, *supra* note 12, at 33 ("When there is a gross disparity in the value that the only competitors for a good attach to it, transaction costs are likely to be high as each competitor vies for the largest possible share of that value."); Paul J. Heald, *Transaction Costs and Patent Reform*, 23 SANTA CLARA COMPUTER & HIGH TECH. L.J. 447, 447 (2007) (evaluating how various proposals for patent law reform impact transaction costs); Lemley, *supra* note 58, at 1507 (discussing the costs of patent licensing and litigation); Merges &

the allocative inefficiencies and deadweight losses mentioned above.[61] For instance, a patent owner may grant a license to a competitor to improve upon a patented technology, thereby reducing the deadweight losses produced by the patent in technology markets. However, such transactions can be difficult to consummate, thereby preventing some parties from obtaining rights to use a patented technology.[62]

The final type of cost that patent scholars typically focus on is the cost of administering the patent system. This cost includes the public and private costs of obtaining patents from the U.S. Patent and Trademark Office and the cost of enforcing patents through litigation.[63] Indeed, some commentators contend that the costs of enforcing patents exceed the benefits in many sectors of the U.S. economy.[64]

Many legal scholars consider the trade-off between the incentive effect of patents and these three types of costs to be the central challenge in designing effective patent laws.[65] These scholars therefore strive to influence lawmakers to develop laws directed toward reducing these costs

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Nelson, *supra* note 11, at 874–75; Sichelman, *supra* note 51, at 368–70 (discussing transaction costs associated with patents).

61. *Cf.* Lemley, *supra* note 58, at 1507 ("The cost of licensing without going to court is also dramatically lower than the cost of litigation."); Long, *supra* note 51, at 635.

62. *See supra* notes 45–48 and accompanying text. In fact, transaction costs for transferring patent rights tend to be high "because by definition [intellectual property] has no unique physical site." *See* LANDES & POSNER, *supra* note 12, at 16; Sichelman, *supra* note 51, at 343–44 (noting that patent rights can give rise to "high bargaining costs").

63. *See, e.g.*, Ghosh & Kesan, *supra* note 14, at 1227 (listing the private and social costs arising from invalid patents); Lemley, *supra* note 58, at 1507–09 (discussing the costs of patent litigation and licensing). Scholars have also argued that patents will sometimes generate additional costs. For example, patent rights may encourage researchers, particularly academics, to keep their work secret before they file for patents. Rebecca S. Eisenberg, *Proprietary Rights and the Norms of Science in Biotechnology Research*, 97 YALE L.J. 177, 183–84 (1987).

64. *See, e.g.*, BESSEN & MEURER, *supra* note 3, at 140 (asserting that "by the late 1990s litigation costs clearly exceeded the profits from patents outside the chemical and pharmaceutical industries").

65. A complete recitation of the scholarship addressing the balancing of incentives and traditional economic costs related to patents is impossible, but examples include: LANDES & POSNER, *supra* note 12, at 22 ("[Exclusive IP] rights reduce the demand for intellectual property by inserting a wedge between price and marginal cost, creating deadweight loss that must be balanced against the disincentive effects of denying the creator of such property a remedy against copiers."); BURK & LEMLEY, *supra* note 51, at 7–8; Abramowicz, *supra* note 43, at 1106; Michael Abramowicz & John F. Duffy, *Intellectual Property for Market Experimentation*, 83 N.Y.U. L. REV. 337, 361–62 (2008) ("After all, a central drawback of intellectual property rights is that they increase deadweight loss, as higher prices mean that some who value goods over marginal cost nonetheless will not purchase them."); Burk, *supra* note 51, at 1618–19; Durham, *supra* note 54, at 975 ("Hence a successful patent system is one in which the public benefit created by encouraging technological advancement more than compensates for the price paid as a consequence of the patentee's monopoly."); Lemley, *supra* note 52, at 1059 ("By definition . . . the intellectual property system permits owners to raise price above marginal cost, creating deadweight losses by raising the price to consumers."); Sichelman, *supra* note 51, at 346, 358 (discussing deadweight loss).

while maintaining robust incentives to innovate.[66] This balance, however, is premised on the belief that the traditional neoclassical economic understanding of patent law comprehensively describes the benefits and costs of patent protection.[67] The next Part of this Article examines whether this belief is warranted.

II. PRODUCTIVE INEFFICIENCY

The application of neoclassical economics to patent law is in many respects useful, but can also be misleadingly incomplete. Neoclassical economics assumes that "firms produce maximum output for given inputs . . . and, therefore, they are cost minimizers."[68] While this assumption greatly simplifies analyses, it does not always align with reality. In fact, many modern economists contend that firms often fail to maximize profits due to productive inefficiencies.

A. *Sources of Productive Inefficiency*

In assuming that firms maximize profits, neoclassical economists ignored much of the internal workings of firms. In contrast, more recent economists more closely examine the conditions that exist within firms and argue that "only individuals think and act, and hence individuals are the proper units of investigation."[69] In focusing on individuals rather than the actors in the aggregate in firms, modern economists have identified numerous interrelated reasons that individuals fail to maximize both their own well-being and firm profits; four of these sources of productive inefficiency are germane to patent law.[70]

66. *See* Abramowicz, *supra* note 43, at 1106 (providing "a possible solution" to the sub-optimal trade-off between incentivizing inventers and ensuring access to inventions); Burk, *supra* note 51, at 1618–19 ("[T]he societal costs the patent system generates must not be allowed to exceed the benefits of the intellectual goods it fosters."). For instance, an invention may not be patented if it "would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains." 35 U.S.C. § 103 (2012). Scholars have justified this basic rule of patent law on the grounds that awarding exclusive rights in such a situation would create a deadweight loss and allocative inefficiency. LANDES & POSNER, *supra* note 12, at 21. The scope of protection afforded to patents is also critical to optimizing the impact of patents on social welfare. This scope depends on numerous factors, including the duration, subject matter limitations, the bases for invalidating patent rights, and the remedies for infringement. *See id*. (discussing the limited duration of patents); Crouch, *supra* note 15, at 141–42 (noting that policy makers must calibrate rights granted by patent protections, "making them strong enough to help induce innovation and development while limiting monopolistic problems"). Issues of patent scope and productive inefficiency are discussed in Section III.D.

67. *See* Vertinsky, *supra* note 32, at 221–26 (providing the common assumptions shared by the "mainstream theories of patents").

68. FRANTZ, *supra* note 17, at 9.

69. *Id.* at 63; *see also id*. at 201 (arguing that productive inefficiency "is a type of inefficiency that results from intrafirm (personal and interpersonal) activities rather than market activities").

70. Other sources of productive inefficiency are not relevant to this Article because patent rights impact them only indirectly. For example, attaining sufficient size to realize meaningful

First, although neoclassical economics posits that humans are guided by a singular, well-defined profit motive, many modern economists contend that human action is the complex product of multiple, competing impulses and modes of thought. For example, psychologists, behavioral economists, and more recently some legal scholars contend that humans exhibit "two kinds of thinking, one that is intuitive and automatic, and another that is reflective and rational."[71] Reflective thought processes are largely consistent with the traditional assumption of profit maximization. When thinking reflectively, people carefully deduce answers and consider the merits of different alternatives.[72] As a result, the reflective approach to decision-making often encourages people to "adhere to standards, to strive for the maximum, and to strive by being calculating and attentive to details."[73]

This deliberative approach to making decisions, however, requires both time and effort. Often, individuals opt instead to make decisions using "automatic" approaches to reach decisions more quickly and with comparatively less effort.[74] Unfortunately, the speed and ease of automatic decision-making often comes at a substantial cost: automatic decisions more often produce incorrect conclusions.[75] Automatic decisions are often distorted by systematic biases—so-called "cognitive biases"—that prevent individuals from reaching accurate conclusions.[76] Cognitive psychologists and behavioral economists have identified many types of cognitive biases and demonstrated that their effects are widespread.[77]

For example, due to the "availability bias," individuals miscalculate the likelihood of an event occurring because individuals often approximate the probability based on "how readily examples come to mind" rather than statistical estimation.[78] The availability of examples, however, is often affected by factors unrelated to the frequency with which an event actually

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economies of scale can increase the productive efficiency of firms. *See* Scherer, *supra* note 56, at 1002–03.

71. *See, e.g.*, THALER & SUNSTEIN, *supra* note 20, at 19.

72. *Id.* at 19–20 (noting that the "Reflective System is more deliberate and self-conscious").

73. FRANTZ, *supra* note 17, at 64; *see also* THALER & SUNSTEIN, *supra* note 20, at 20 (noting that the reflective cognitive system is, *inter alia*, controlled, deductive, and rule-following). In this limited respect, modern scholars agree with traditional economists regarding the behaviors of individuals.

74. FRANTZ, *supra* note 17, at 65, 75; THALER & SUNSTEIN, *supra* note 20, at 19–22 ("The Automatic System is rapid and is or feels instinctive, and it does not involve what we usually associate with the word *thinking*.").

75. *See* THALER & SUNSTEIN, *supra* note 20, at 21–22 (noting that cognitive mistakes are often made because people rely too heavily on the automatic system).

76. *Id.* at 22–23.

77. *See, e.g.*, FRANTZ, *supra* note 17, at 67–69 (discussing the cognitive biases known as representativeness, availability, and anchoring); THALER & SUNSTEIN, *supra* note 20, at 19–37 (discussing several types of cognitive biases); Jaros, *supra* note 20, at 1979–80 (noting the cognitive errors resulting from various cognitive biases).

78. THALER & SUNSTEIN, *supra* note 20, at 25.

occurs. For instance, some events, like plane crashes and murders, are particularly newsworthy and easy to remember. As a result, people often incorrectly believe that air travel is less safe than traveling by car or that homicide is more common than less publicized causes of death like suicide.[79] In actuality, air travel is over seventy times safer than travelling by car for an equivalent distance and suicide is approximately twice as common as murder.[80]

Another widely recognized cognitive bias is "loss aversion," which arises when individuals weigh more heavily the harm from losing something than the gain from acquiring it.[81] As a result of loss aversion, an individual may choose not to relinquish a less valuable asset even to gain something more valuable. Consequently, "[l]oss aversion helps produce inertia, meaning a strong desire to stick with your current holdings . . . . even when changes are very much in [the individual's] interests."[82] Loss aversion is further complicated by the so-called "hyperbolic discounting" of future losses. Under traditional economics, individuals discount future gains and losses at a constant rate.[83] Empirical studies indicate, however, that individuals discount future events at a much higher rate and value present costs and benefits substantially more than those in the future.[84] As a result, individuals fail to delay gratification at the rate predicted by traditional economics.[85] Behavioral economists assert that hyperbolic discounting helps to explain the existence of many problems involving excessive short-term consumption, including smoking and consumer debt.[86]

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79. *Id.* at 25 (noting that risks familiar to human cognition, such as acts of terrorism and homicide "will be seen as more serious than a risk that is less familiar").

80. Bourree Lam, *Suicide vs. Homicide by State, per 100,000*, FREAKONOMICS, (Sept. 1, 2011, 9:29 AM), http://freakonomics.com/2011/09/01/suicide-vs-homicide-by-state-per-100000/; Matthew Yglesias, *Passenger Airplanes Are Amazingly Safe*, SLATE, (July 6, 2013, 4:39 PM), http://www.slate.com/blogs/moneybox/2013/07/06/passenger_airplanes_are_amazingly_safe.html.

81. THALER & SUNSTEIN, *supra* note 20, at 33–34.

82. *Id.* at 34. Other well-known cognitive biases include the anchoring bias, the representativeness bias, the optimism bias, and the status quo bias. *Id.* at 23–24, 26–35. A full account of cognitive biases is beyond the scope of this Article.

83. Oren Bar-Gill, *Seduction by Plastic*, 98 NW. U. L. REV. 1373, 1396 n.114 (2004); *see also* Wright & Stone, *supra* note 30, at 1531. For example, neoclassical economics assumes that an individual would determine the value of receiving $1,000 ten years in the future by determining the amount of money that must be invested today in order to grow to $1,000 in ten years. If the interest rate for the next ten years is 5%, the present value of $1,000 is $613.91.

84. Bar-Gill, *supra* note 83, at 1396 ("Th[e] systematic disparity between people's short-term and long-term discount rates has been consistently demonstrated both in the laboratory and in real-world settings."); *id.* at 1396 n.115 (collecting sources demonstrating the systematic disparity between short and long-term discount rates).

85. *See* Wright & Stone, *supra* note 30, at 1532.

86. Bar-Gill, *supra* note 83, at 1395–99; *see* Jonathan Gruber & Botond Koszegi, *Is Addiction "Rational"? Theory and Evidence*, 116 Q.J. ECON. 1261, 1293–94 (2001).

At times, people are aware of the costs and benefits of reflective and automatic decision-making and can choose between these approaches intelligently.[87] For example, individuals may embrace self-paternalistic measures to prevent their automatic decision-making systems from undermining careful, reflective decisions, such as when a person who is dieting decides not to buy a tempting food rather than to buy it but eat less. Cognitive biases, however, are difficult to resist, particularly "when choices and their consequences are separated in time."[88] Ultimately, individuals make many decisions without carefully choosing between reflective and automatic approaches.[89]

A second reason that individuals fail to maximize firm profits is that even when individuals intend to think rationally and carefully, they face substantial cognitive limitations. As Nobel Prize winning economist Herbert Simon observed more than fifty years ago, "[t]he capacity of the human mind for formulating and solving complex problems is very small compared with the size of the problems whose solution is required for objectively rational behavior in the real world . . . ."[90] Many economists thus posit that humans exhibit at most "bounded rationality."[91] One important reason that humans are boundedly rational is that neurological structures and processes in the human brain create "rate and storage limits on the powers of individuals to receive, store, retrieve, and process information without error."[92] Humans also face difficulties in translating ideas into forms that can be effectively communicated to others.[93] Thus, the bounded rationality of humans most significantly affects decision-making in situations involving complexity and uncertainty. For example, humans often have a poor intuitive grasp of statistics and probability, and consequently fail to effectively distinguish between patterns and randomness.[94] Facing complexity and uncertainty, individuals therefore

87. *See* THALER & SUNSTEIN, *supra* note 20, at 44.

88. *Id.* at 73. For example, many people fail to stick to their New Years' resolutions.

89. Similarly, when facing a decision with significant emotional ramifications, individuals may make decisions based on those emotions and, once free from emotional strain, lament their moments of weakness. *See* FRANTZ, *supra* note 17, at 206 ("Sometimes we are tired, sometimes we are angry, jealous, afraid. We often . . . look back and regret the decisions we make.").

90. SIMON, *supra* note 20, at 198 (emphasis omitted); *see also* WILLIAMSON, *supra* note 15, at 21 (positing that human behavior, while intended to be rational, is only limitedly so).

91. SIMON, *supra* note 20, at 198; WILLIAMSON, *supra* note 15, at 21.

92. WILLIAMSON, *supra* note 15, at 21.

93. *Id.* at 22.

94. *See generally* LEONARD MLODINOW, THE DRUNKARD'S WALK: HOW RANDOMNESS RULES OUR LIVES (2008) (describing the inability of many people to understand statistics or to recognize the effects of randomness); SCHERER, *supra* note 26, at 29–30 (noting that some economists argue that "many business people are poorly informed about business conditions in general, know almost nothing about the concept of probability, and understand only crudely the logic of profit maximization, i.e., what variables must be taken into account, such as marginal cost and marginal revenue, and how they must be related to maximize profits"); Crouch, *supra* note 15, at 161 (noting

employ simplifying strategies and heuristics.[95] In doing so, however, "'approximation must replace exactness in reaching a decision.'"[96] While often useful, "heuristics can also lead to serious errors in judgment."[97] When complexity and uncertainty force employees to use heuristics, errors are often inevitable and firms will accordingly fail to maximize profits.

A third reason that individuals may prevent firms from maximizing profits stems from the individuals' reliance on habits to determine their behavior.[98] For instance, an employee may continue to utilize an approach to her job even after changes in the market or new technologies create opportunities for improvement. Of course, habits are not inherently inefficient. Habituated behavior may allow individuals to work more quickly and some habits can increase employee productivity, like double-checking the accuracy of work. Maintaining less effective habits may also be justified when the cost of developing new, better habits requires a substantial investment of time and energy.[99] For example, even if a new technology can theoretically increase firm profits, the costs of changing old, technologically outdated habits may exceed the benefits.[100]

Despite the potential benefits of habituated behaviors, it is unlikely that employees always use habits in a cost-justified manner. In many cases, people decide to maintain habits using the automatic mode of decision-making described above[101] without effectively weighing the costs and benefits of that decision.[102] Cognitive biases also limit the capacities of individuals to effectively rely on habits. For example, psychological studies demonstrate that individuals often exhibit a strong cognitive bias in favor of preserving the status quo, causing well-established bad habits to

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that the "lottery effect" affects potential innovators, "causing them to exhibit the skewed preferences of the patent lottery and thus be willing to invest against the actuarial norm").

95. *See* THALER & SUNSTEIN, *supra* note 20, at 37 (arguing that people adopt sensible "rules of thumb" to cope with questions in a complex world).

96. WILLIAMSON, *supra* note 15, at 23 (quoting Herbert A. Simon, *Theories of Bounded Rationality*, *in* 12 DECISION AND ORGANIZATION 170 (C. McGuire & R. Radner eds., 1972)).

97. FRANTZ, *supra* note 17, at 67.

98. *See* FRANTZ, *supra* note 17, at 74–78; CAVES & BARTON, *supra* note 19, at 132 ("A complex organization develops a set of routines that draw on decentralized knowledge and suffice as responses to the range of disturbances that ordinarily intrude.").

99. *See* WILLIAMSON, *supra* note 15, at 121 (noting that employees may continue an activity because of the "sunk costs" invested in that activity).

100. *See also id.* ("The sunk costs in programs and facilities of ongoing projects thus insulate existing programs from displacement by alternatives which, were the current program not already in place, might otherwise be preferred.").

101. *See* THALER & SUNSTEIN, *supra* note 20, at 43 ("In many situations, people put themselves into 'automatic pilot' mode, in which they are not actively paying attention to the task at hand. (The Automatic System is very comfortable that way.)"); *see also id.* (providing examples of resorting to routine or habit while operating under the automatic state of cognition).

102. FRANTZ, *supra* note 17, at xvii, 79.

persist.[103] Further, it is often difficult for individuals to determine that a once-good habit has become ineffective due to changes in technological or market conditions, in part because humans often become desensitized to environmental stimuli and will not perceive environmental changes unless they exceed a sufficient magnitude.[104] A final reason that employees will not maximize firm profits is that employees often pursue goals at work that conflict with the profit related objectives of the firm, such as on-the-job leisure, personal relationships, perquisites, power, and prestige.[105] One important individual goal that frequently undercuts firm profits is an individual's desire to conserve his or her own efforts.[106] Such efforts in conservation may cause an individual to embrace automatic and intuitive decision-making processes when more conscientious decision-making would better serve the firm. Employees may also deliberately limit their efforts by shirking their responsibilities.[107] Although shirking reduces firm profits, an employee enjoys the full benefit of reduced effort but only a portion of the cost because the losses from shirking are typically spread across the entire firm.[108] Even diligent employees may not maximize firm profits if they strive to maximize value on a timetable that is shorter than

103. THALER & SUNSTEIN, *supra* note 20, at 34.

104. *See id.* at 34–35 (discussing status quo bias); FRANTZ, *supra* note 17, at 77–78.

105. *See, e.g.*, CAVES & BARTON, *supra* note 19, at 5, 65 (noting that the coalition of workers that comprises firms may falter ex post "through shirking other opportunistic behavior by some members of the coalition"); FRANTZ, *supra* note 17, at 38, 188 (describing trade-offs between employees' on-the-job leisure and profits); LEIBENSTEIN, *supra* note 17, at 27 (explaining ways agents of firms will make decisions in their own interest); WILLIAMSON, *supra* note 15, at 119 (discussing how internal social relations of a firm can undermine the profit-related goals of the firm in the procurement context); Merges, *supra* note 21, at 26 (noting that "employees will maximize their own utility, rather than their employer's"); Posner, *supra* note 5, at 574–75 (describing reasons why a manager of a monopoly might divert firm resources to redecorating the corner office).

106. FRANTZ, *supra* note 17, at 55 (asserting that "workers have effort discretion which makes their performance dependent upon motivation"). Employment contracts generally give employees some discretion over the amount of effort to apply to their jobs. *See id.* at 74 (providing that firms "buy labor *time*," yet human effort "is not directly purchased"). Indeed, at the time of hiring, employers are often unable to describe in detail the specific tasks employees must perform, and instead must describe job responsibilities in broader, discretion-laden terms. *See* WILLIAMSON, *supra* note 15, at 124 (noting that "the joining of bounded rationality with uncertainty makes contractual completeness expensive (if not infeasible) to attain"); *cf.* H. L. A. HART, THE CONCEPT OF LAW 127–28 (2d ed. 1994) (discussing legal indeterminacy). Moreover, firms are often unable to determine ex ante the output that an employee should produce based on given inputs. FRANTZ, *supra* note 17, at 55.

107. *See* CAVES & BARTON, *supra* note 19, at 65 (noting the limits of employment contracts given shirking and opportunistic behavior).

108. *See* FRANTZ, *supra* note 17, at 90; Merges, *supra* note 21, at 22 & n.72 (discussing shirking). Conversely, an exceptionally diligent employee bears the entire cost of such industrious behavior but likely enjoys only a portion of any increased firm profits. The incentive structure facing employees and managers thus can be understood as a prisoner's dilemma. When each individual adopts a rational maximization strategy, the result is an inferior outcome for all individuals. FRANTZ, *supra* note 17, at 90–93.

the firm's.[109] For example, an employee may strive to maximize quarterly profits to please shareholders when the firm's profits ultimately would be increased in the long-term by a strategy involving short-term losses.[110] This view of employee motivation conflicts with traditional economic accounts: "In conventional [neoclassical economics] all economic activity takes place between principals, or, to the extent that agents exist, they are presumed to act entirely in accord with the interests of the principals."[111] When employees pursue non-profit goals, firm profits suffer.[112]

B. *Effects of Productive Inefficiency*

As described above, well-functioning markets generally enhance social welfare because voluntary transactions generate wealth in the form of consumer and producer surpluses.[113] As a result, conditions that cause parties to consummate fewer transactions reduce the total welfare of society.[114] For example, as recognized by traditional neoclassical economics, monopoly prices harm society because some consumers will be unable to afford them.[115]

Although ignored by neoclassical economics, productive inefficiencies produce a similar reduction in social welfare. When firms suffer from productive inefficiencies, employees are less effective in turning inputs into outputs, and firms consequently face higher costs in producing goods and services. Such firms therefore produce smaller quantities and charge higher prices that some consumers cannot afford.[116] As a result, when productive inefficiencies affect a large part of a market, they create a deadweight loss, which reduces social welfare.[117] Importantly, the losses to

109. Hyperbolic discounting exacerbates this problem. *See supra* notes 83–86 and accompanying text (discussing hyperbolic discounting).

110. *See* SCHERER, *supra* note 26, at 30 (theorizing that a monopolistic firm may not choose to exploit its monopoly power in order to build customer loyalty at expense of short term profits).

111. LEIBENSTEIN, *supra* note 17, at 26–27.

112. Profit-sharing schemes can help to align the incentives of employees and their superiors, but "[e]ven the best-designed employee bonus and profit-sharing systems seldom succeed in instilling much zeal for profit maximization below the middle management level." SCHERER, *supra* note 26, at 31.

113. *See supra* notes 36–40 and accompanying text.

114. *See* MANKIW, *supra* note 17, at 159 (noting that taxation creates a disincentive for buyers to consume and sellers to produce, which then diminishes market size to a suboptimal level).

115. *See supra* notes 41–44 and accompanying text.

116. *See* Posner, *supra* note 5, at 577 ("[M]oney expended to hire more of the factors of production than actually needed to conduct a business diverts resources from more productive activities, and this effect is not only additive to, but could be many times greater than, the social cost in allocative inefficiency.").

117. *See supra* notes 42–43 and accompanying text. However, not all increased costs that firms face due to productive inefficiencies reduce social welfare because the firm's loss is sometimes an employee's gain. *See* FRANTZ, *supra* note 17, at 188 (explaining that employee leisure may represent a nontraded commodity enjoyed as utility by employees as firm "output"); Posner, *supra*

society stemming from productive inefficiencies are not merely theoretical, as numerous empirical studies have identified significant economic losses due to productive inefficiencies.[118] One study estimates that losses due to productive inefficiencies are equal to as much as 20% of the U.S. economy.[119] Additional empirical evidence regarding productive efficiencies is discussed below.[120]

C. *Reducing Productive Inefficiency*

1. Competition

An important insight of the economic literature regarding productive inefficiency is that competition can substantially reduce the social harms of productive inefficiency.[121] Robust competition reduces productive inefficiency in at least three interrelated ways.[122] First, competition

note 5, at 575 (describing the benefit of "[m]anagerial self-indulgence" in the context of monopoly firms). For instance, when an employee shirks his responsibilities in order to take an extra break, the employee receives the benefit of on-the-job leisure time. It is unlikely, however, that employees value such "nontraded" commodities like on-the-job leisure time at a sufficiently high rate to completely offset the harm to firm profits. *See* FRANTZ, *supra* note 17, at 191–93.

118. *See, e.g.*, FRANTZ, *supra* note 17, at 136 (providing examples of economic losses due to productive inefficiencies); THOMAS J. HOLMES & JAMES A. SCHMITZ, JR., FED. RESERVE BANK OF MINNEAPOLIS, COMPETITION AND PRODUCTIVITY: A REVIEW OF EVIDENCE 3 (2010) (reviewing numerous empirical studies and concluding that they demonstrate that "increased competition raised industry productivity"), *available at* http://www.minneapolisfed.org/research/sr/sr439.pdf; Lucian Arye Bebchuk & Assaf Hamdani, *Vigorous Race or Leisurely Walk: Reconsidering the Competition over Corporate Charters*, 112 YALE L.J. 553, 598 (2002) (reviewing empirical studies confirming that "monopolies tend to produce less efficiently than players in a competitive market"); Gerla, *supra* note 17, at 224 (noting that empirical studies demonstrate that production inefficiency, otherwise known as "X-inefficiency," indeed exists, and that firms suffer from production inefficiencies that are often severe); Harvey Leibenstein, *Allocative Efficiency vs. "X-Efficiency,"* 56 AM. ECON. REV. 392, 406 (1966) ("The main burden of these findings is that [productive inefficiency] exists, and that improvement in [productive efficiency] is a significant source of increased output.").

119. Gerla, *supra* note 17, at 227. In contrast, some estimates of losses from allocative efficiency are small. For example, one economist has "estimated that the welfare loss due to monopoly power was approximately one-tenth of one percent of the U.S. gross national product." FRANTZ, *supra* note 17, at 2; *accord* Leibenstein, *supra* note 118, at 392 (noting that empirical studies suggest that "the problem of allocative efficiency is trivial"). *But see* BOLDRIN & LEVINE, *supra* note 51, at 69 ("Although the current tendency in economics is to argue that the welfare triangle is not large, in the case of innovation this is not always true.").

120. *See infra* notes 141–44 and accompanying text.

121. *See* FRANTZ, *supra* note 17, at 57 (arguing that competition can lead individuals to feel driven to realize potential); *id.* at 98; THALER & SUNSTEIN, *supra* note 20, at 48 (noting that "markets provide self-control services").

122. Lack of competition is not the only source of productive inefficiency. *See* CAVES, *supra* note 19, at 11–17 (discussing numerous sources of productive inefficiency); CAVES & BARTON, *supra* note 19, at 72–85 (describing various technical inefficiencies); Alison Green & David Mayes, *Technical Inefficiency in Manufacturing Industries*, 101 ECON. J. 523, 523 (1991) (discussing empirical studies regarding inefficiency across industries in the United Kingdom). Indeed, even in

eliminates productively inefficient firms from the market.[123] Firms and business units within firms often vary in the nature and extent of their productive inefficiencies.[124] For instance, the effects of cognitive biases on an employee are often affected by the "choice architecture" in which the employee makes decisions, including the default rules that apply in the absence of a decision, whether processes are designed to account for employee errors, and the mechanisms for providing feedback to employees after a decision has been made.[125] Through competition, businesses with better choice architecture will push from the market rivals who suffer more from egregious cognitive biases.[126] Similarly, firms likely differ in the extent to which employees can pursue goals that undermine employer profits. For example, some firms may offer generous perquisites like company cars and richly appointed or architecturally ambitious offices.[127] Competition may eliminate from the market—or at least reduce the market share of—these productively inefficient firms.[128] Differerences in the

competitive industries, employees sometimes may choose to pursue their own objectives rather than tirelessly strive to maximize profits for their employers. A well-known example of this problem arises every year on "Cyber Monday," when millions of employees shop online from their places of employment on the Monday after Thanksgiving. According to one study, 86% of employees planned to shop while at work on Cyber Monday in 2013, leading to an estimated productivity loss for employers valued at $2.5 billion. *RetailMeNot Shoppers Trend Report: One in Four Consumers Plan to Spend at Least Half of Their Workday Shopping Online on Cyber Monday*, RETAILMENOT (Nov. 25, 2013), http://retailmenot.mediaroom.com/2013-11-25-RetailMeNot-Shoppers-Trend-Report-One-in-Four-Consumers-Plan-to-Spend-at-Least-Half-of-Their-Workday-Shopping-Online-on-Cyber-Monday.

123. *See* FRANTZ, *supra* note 17, at 96 ("X-efficiency cannot continue unabated. Pressure mounts as costs increase and profits decrease, and/or the threat imposed by new competition creates a serious threat to jobs and incomes."); HOLMES & SCHMITZ, *supra* note 118, at 7 (discussing the reallocation of market share from lower productivity enterprises to higher productivity enterprises).

124. *See* CAVES & BARTON, *supra* note 19, at 68 ("In seeking productivity improvements and reacting to economic changes, the individual[] firms and plants in an industry continually perform experiments."). Empirical productivity studies are consistent with this variability. For example, a study of 102 U.S. manufacturing industries found that the productivity in the top quartile of plants was at least 25% higher than the average for that industry. *Id.* at 2. Typically, the top quartile of plants was 65% more productive than the industry average. *Id*.

125. *See generally* THALER & SUNSTEIN, *supra* note 20, at 83–100 (explaining the six principles of "choice architecture").

126. *See id.* at 252 ("Choice architecture, both good and bad, is pervasive and unavoidable, and it greatly affects our decisions.").

127. One example of this type of productive inefficiency may be lavish corporate facilities. For example, Apple, Inc. has announced plans to create a futuristic new corporate campus at a cost of approximately $5 billion. Peter Burrows, *Inside Apple's Plans for Its Futuristic, $5 Billion Headquarters*, BLOOMBERG BUSINESSWEEK, (Apr. 4, 2013), http://www.businessweek.com/articles/2013-04-04/apples-campus-2-shapes-up-as-an-investorrelations-nightmare.

128. *See* CAVES & BARTON, *supra* note 19, at 68 ("External competition limits this opportunism because the presence of efficient rivals (or the threat of their entry) constrains the amount of slack a firm's participants can absorb . . . ."); SCHERER, *supra* note 26, at 38 ("No matter how strongly managers prefer to pursue other objectives, and no matter how difficult it is to find

internal hierarchical structure and organizational schemes of some firms may facilitate supervision by management and reduce productive inefficiencies of employees.[129] Through competition, those firms with more effective internal structures will predominate.

Second, competition reduces productive inefficiency by increasing the information exchange between rivals.[130] For example, the success of competitors may help a firm to identify circumstances in which its employees are underperforming, perhaps because employees are pursuing personal goals that undermine firm profits. As employees move between firms, superior organizational structures and choice architectures may also be shared.[131] Furthermore, success or failure in competing with rivals may provide employees with information regarding the consequences of their decisions, and such feedback can help employees to address poor decision-making stemming from cognitive biases and bounded rationality.[132] Competitive threats can also reveal the inefficacy of old habits and the costs of decisional inertia, prompting employees to be more alert and cost-conscious.[133] "Wherever competition is absent, there is a disposition to rest content with old methods, not to say slack ones."[134]

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profit-maximizing strategies in a world of uncertainty and high information costs, failure to satisfy this criterion means ultimately that a firm will disappear from the economic scene."); Posner, *supra* note 5, at 575 ("A management not forced to reduce costs to the bone in order to survive is free to take a more strategic attitude toward corporate and personal destiny than one constrained by the market to pursue cost minimization and immediate profit maximization.").

129. For example, large peer groups may be particularly subject to collective action problems and may also face increased costs in distributing information to their members. MANCUR OLSON, JR., THE LOGIC OF COLLECTIVE ACTION: PUBLIC GOODS AND THE THEORY OF GROUPS 53–65 (1965) (discussing the increased effectiveness of small groups of people); *see also* WILLIAMSON, *supra* note 15, at 45–47 (discussing various constraints on peer groups). Hierarchy can ameliorate some of these concerns. *Id*. at 47.

130. *See* CAVES, *supra* note 19, at 9 ("[W]hen the number of market participants is small, there are fewer agents to experiment and try for improved ways of doing things, and fewer peers from whom to learn."); CAVES & BARTON, *supra* note 19, at 68–69 (arguing that competitors increase technical efficiency by engaging in diffusion of information); SCHERER, *supra* note 26, at 38 ("[K]nowledge that only the fit will survive provides a potent incentive for all firms to *adapt* their behavior in profit-maximizing directions, learning whatever skills they need and emulating organizations that succeed in the survival game."); Posner, *supra* note 5, at 574 ("Under competition, a firm either learns from its most efficient rival or goes under; either way production ends up at the least-cost level.").

131. *See supra* note 126 and accompanying text (discussing choice architecture).

132. *See* THALER & SUNSTEIN, *supra* note 20, at 75 ("Learning is most likely if people get immediate, clear feedback after each try.").

133. *See* FRANTZ, *supra* note 17, at 96.

134. Arthur Twining Hadley, *The Good and Evil of Industrial Combination*, ATLANTIC MONTHLY, Mar. 1897, at 383. Judge Learned Hand made a similar and more detailed observation more than sixty years ago: "Many people believe that possession of unchallenged economic power deadens initiative, discourages thrift and depresses energy; that immunity from competition is a narcotic, and rivalry is a stimulant, to industrial progress; that the spur of constant stress is

Third, competition can reduce productive inefficiencies by deterring employees from pursuing individual goals that undermine firm profits. When individual contributions do not significantly affect the firm's success, an employee may be inclined to engage in selfish behavior.[135] Facing competition, however, an employee's selfish behavior may impact the firm more significantly, and the cost to the employee from a wage reduction or loss of employment may outweigh the benefits to the employee from opportunistic behavior.[136] Similarly, facing robust competition and the resulting threat to the firm's survival, managers may be less reluctant to engage in the critical supervision necessary to increase productivity even if such supervision strains interpersonal relationships, requires additional effort, and exposes managers to greater scrutiny by higher level management.[137] When competition threatens the firm, employees may also be more receptive to managerial supervision even if those employees do not otherwise enjoy the changes wrought by management.[138] Therefore, "competition reduces the opportunity to engage in the various forms of discretionary behavior available to (some) employees of the monopolist, including behaving in an arbitrary sloppy, bureaucratic, arrogant, and nonresponsive fashion."[139]

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necessary to counteract an inevitable disposition to let well enough alone." United States v. Aluminum Co. of Am., 148 F.2d 416, 427 (2d Cir. 1945).

135. *See* OLSON, *supra* note 129, at 62 (arguing that individuals in large, latent groups will likely not be influenced by social incentives to obtain the common good).

136. WILLIAMSON, *supra* note 15, at 242–43 (noting that without competition "the management and workers in the firm [may] take part of their rewards as on-the-job leisure"). In a sense, competition causes employees to internalize part of the cost of the productive inefficiency that the employee imposes on the firm. Competition among employees may reduce opportunistic behavior as one employee's diligence reveals the opportunism of another. *Id*. at 27 ("[R]ivalry among large numbers of bidders will render opportunistic inclinations ineffectual. Parties who attempt to secure gains by strategic posturing will find . . . that such behavior is nonviable."). However, social interactions among employees may reduce this form of competition. Peer pressure can encourage harder working employees to reduce their efforts because one individual can "make others look bad by working too hard." FRANTZ, *supra* note 17, at 87; *see also* LEIBENSTEIN, *supra* note 17, at 33 (noting that peers "are likely to impose themselves on the more energetic workers in the firm, to reduce their norms towards somewhat lower levels and to increase the levels for especially unenergetic individuals").

137. *See* FRANTZ, *supra* note 17, at 59 (arguing that individuals within organizations will be more likely to forego greater effort where competition is light and forego leisure when competition is high); Gilbert, *supra* note 26, at 205 (suggesting that competition may make firms attune to inefficient outputs by employees). As Adam Smith observed more than two centuries ago, "[m]onopoly . . . is a great enemy to good management." ADAM SMITH, WEALTH OF NATIONS 147 (Random House, 1937).

138. *See, e.g.*, FRANTZ, *supra* note 17, at 102 (noting a change in attitude among employees whose plant faced shutdown); *id.* at 59 ("[I]n situations where competitive pressures are high, and hence the costs of [trading disutility of greater effort for leisure] are also high, they will exchange less of the disutility of effort for the utility of freedom from pressure . . . ." (internal quotation marks omitted)); HOLMES & SCHMITZ, *supra* note 118, at 17–21 (providing examples of employees and employee-unions accepting management-directed change in the face of increasing competition in the iron ore manufacturing industry).

139. FRANTZ, *supra* note 17, at 98.

Empirical studies confirm that heightened competition can reduce productive inefficiencies, thereby increasing the productivity of firms.[140] Studies of early shipping industries, the U.S. iron industry, and the U.S. cement industry have found that increased competition led to significant productivity improvements as employees became more receptive to managerial supervision that granted the employees less on-the-job leisure time.[141] Other empirical studies have reported that competition increased productivity by encouraging investment in new technologies and by eliminating low-productivity firms from the market.[142] Similarly, empirical studies of trade liberalization have found that reductions in tariffs often increase the productivity of domestic firms.[143] Most significantly, broad-based studies of productive efficiency in many different countries have confirmed that a lack of competition often exacerbates productive inefficiencies.[144]

Increased competition thus can improve productive efficiency and increase social welfare. Nevertheless, firms are often reluctant to support policies that would intensify competition. Although intensified competition may make a firm more productively efficient, that same competition could reduce the firm's profits if the firm loses market share due to increased competition.[145] Similarly, competition may undermine the job security or compensation of individual employees. For instance, employees who enjoy substantial on-the-job leisure and perquisites may not want to lose those benefits to increased competition. Even firms that do not lose market share may be reluctant to embrace greater competition if it leads to reduced prices and thus lower firm profits.[146] As a result, some employees and firms may seek to improve productive inefficiency through a different mechanism: managerial supervision.

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140. Scherer, *supra* note 56, at 1004 & n.16.

141. HOLMES & SCHMITZ, *supra* note 118, at 14–22, 25–26.

142. *Id.* at 23, 27–28.

143. *Id.* at 29–33.

144. CAVES, *supra* note 19, at 11–12 (discussing effects of external and domestic competition). *But see* Dayna B. Matthew, *Doing What Comes Naturally: Antitrust Law and Hospital Mergers*, 31 HOUS. L. REV. 813, 830–32 (1994) (asserting that the prevalence of productive inefficiencies in the context of monopolies is "based more upon intuition than empirical evidence"). Empirical studies also indicate that competition promotes competitiveness in global markets. *See* MICHAEL E. PORTER, THE COMPETITIVE ADVANTAGE OF NATIONS 117 (1990) ("In global competition, successful firms compete vigorously at home and pressure each other to improve and innovate."). Some empirical studies indicate that increases in competition can reduce firm productivity when increased market concentration is required to achieve greater economies of scale. CAVES & BARTON, *supra* note 19, at 69; FRANTZ, *supra* note 17, at 167–68. Firm productivity, however, is distinct from productive inefficiency, and some empirical studies of productive inefficiency therefore try to control for considerations of scale. CAVES & BARTON, *supra* note 19, at 67.

145. For example, if competitors enjoy greater gains in productive efficiency a less productively efficient firm may be weeded out of the market.

146. In such a situation, the consumer surplus would increase. *See supra* notes 40–44 and accompanying text.

2. Limits on Managerial Supervision

Undoubtedly, managers can encourage employees to work more effectively through supervision, threats of termination, and financial inducements.[147] However, the capacity of management to reduce productive inefficiency is often limited because productive inefficiencies affect managers as well as employees. Managers often suffer from cognitive biases and bounded rationality, rely on outdated habits and technologies, and pursue nonprofit objectives like power, prestige, and on-the-job leisure.[148]

Indeed, managers may face additional challenges in gathering accurate information regarding the activities of their subordinates. Managers are often unable to determine ex ante the output that an employee should produce based on given inputs,[149] and when managers supervise numerous employees who all perform complex tasks, problems of bounded rationality are particularly likely to hamper efforts to gather information regarding the performance of those subordinates.[150] Moreover, employees often strive to conceal their mistakes and opportunistic behavior from their managers.[151] Furthermore, when managers rely on inaccurate information, subordinates may be reluctant to disagree and provide more accurate information due to concerns that the manager will react negatively to the correction.[152] Even when a manager knows that an employee is shirking, the manager may pursue the nonpecuniary goal of harmonious interpersonal relationships by avoiding the conflict-laden task of reprimanding the subordinate.[153]

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147. *See* FRANTZ, *supra* note 17, at 84 (assuming that "vertical relations" exert pressure for effort and that employees receive satisfaction from approval from supervisors); LEIBENSTEIN, *supra* note 17, at 29 ("The main reason for emphasizing the contrast between effort positions and effort points is the nature of the signals received by an employee . . . indicating varying *demands* for effort. When heeded, such signals, as usually interpreted, trigger what the individual believes to be the appropriate effort response or one that he likes to give."); WILLIAMSON, *supra* note 15, at 54 (discussing the effects of employment hierarchy).

148. *See supra* Section II.A; *see also* WILLIAMSON, *supra* note 15, at 126–27 (noting that managers suffer from bounded rationality).

149. FRANTZ, *supra* note 17, at 55 ("[Managers] do[] not always know in advance the quantity of output which will be received from given inputs and input ratios.").

150. "Bounded rationality gives rise to finite spans of control together with the specialization of communication and decision-making functions." WILLIAMSON, *supra* note 15, at 126 (footnote omitted). As a result, as firms grow in size, a "control loss phenomenon" arises. *Id.*(internal quotation marks omitted); *accord* SCHERER, *supra* note 26, at 31 ("The more hierarchical filters through which information passes, the more distorted the information is likely to become . . . .").

151. *See* WILLIAMSON, *supra* note 15, at 9, 26, 122. Even mid-level managers may "conceal or gloss over operating problems until the situation has deteriorated beyond repair." SCHERER, *supra* note 26, at 31.

152. WILLIAMSON, *supra* note 15, at 122 (noting that subordinates "may tell their supervisor what he wants to hear; assertively, they will report those things they want him to know").

153. *See* SCHERER, *supra* note 26, at 31–32. Furthermore, managerial oversight may produce counterproductive results because close supervision can undermine employee motivation due to the

In light of these manifold challenges in supervising employees, managers may evaluate employee performance by focusing on aspects of a job that are more amendable to quantification but do not fully reflect an employee's contribution to the employer's commercial success.[154] For example, a managing partner in a law firm may focus on the number of hours that a young associate attorney bills rather than the quality of the associate's work during those hours. Such an approach to supervision encourages employees like the associate attorney to focus on the measured aspect of their responsibilities to the detriment of other aspects of their jobs that are important to firm profits but more difficult to quantify.[155] Indeed, social scientists have demonstrated that merely measuring a behavior can affect its frequency.[156] One particularly problematic aspect of this phenomenon arises when failure is easier to measure than success.[157] An employee in such a situation will discount the benefits of success and overreact to the costs of failure.[158] Consequently, the employee may become excessively risk averse and avoid taking otherwise cost-justified risks.[159] Similarly, employees who encounter failure due to factors beyond

"dissatisfaction of not being one's own master." FRANTZ, *supra* note 17, at 86, 99; *see* WILLIAMSON, *supra* note 15, at 55 (noting that hierarchies may be disruptive because "transparent inequality of rank [is] considered objectionable by some individuals" and "auditing and experience-rating may offend their sense of individual and collective well-being"); Merges, *supra* note 21, at 28 (noting that managerial scrutiny of researchers can be "counterproductive"). Some managers may be more successful in navigating these difficulties than others, but identifying and promoting such high-quality managers can be difficult due to productive inefficiencies at higher levels of management. *See* WILLIAMSON, *supra* note 15, at 52, 230 ("Many managers are involved, but the exceptional ones can be discerned only with difficulty."); *see also id.* at 24 ("If the specialization of labor is feasible, those whose rationality limits are less severely constrained than others are natural candidates to assume technical, administrative, or political leadership positions—which is to say that a hierarchy can emerge on this account.").

154. *See* Merges, *supra* note 21, at 3 ("[P]rincipal-agent theory . . . demonstrates that when employees are assigned to multiple tasks . . . managers must take care lest employee compensation be tied too closely to one measurable task.").

155. *See id.* at 29 (stating that if one of the multiple tasks assigned by management "pays better than the others, that task will get an inordinate amount of the employees' attention" and that this dynamic can have a "detrimental effect on teamwork").

156. THALER & SUNSTEIN, *supra* note 20, at 70 (discussing the "mere-measurement effect"). For example, merely asking people whether they intend to floss will increase the likelihood that those people will in fact floss their teeth. *Id.*

157. *See* WILLIAMSON, *supra* note 15, at 121 (positing that "it may be impossible . . . to easily distinguish between faulty and meritorious internal performance").

158. The loss-aversion bias further exacerbates this tendency. *See supra* notes 81–82 and accompanying text. Other cognitive biases, however, may temper this effect. *See* THALER & SUNSTEIN, *supra* note 20, at 31–32 (describing the "optimism bias" under which individuals are "unrealistically optimistic").

159. One way to mitigate these types of problems is to uncouple compensation from performance. For example, "corporate R&D personnel generally receive their salary whether or not a particular line of research pans out. They do not give back their salary when an experiment goes awry or a product design proves unworkable." Merges, *supra* note 21, at 31. On the other hand, when compensation is not tied to performance, shirking is more likely to occur.

their control may "press for program extensions beyond objectively rational cut-off limits in the hopes that the environment will change and 'save' their reputations."[160]

III. PRODUCTIVE INEFFICIENCY AND PATENTS

Although modern economic models consider the sources and effects of productive inefficiency, legal scholars and lawmakers have failed to apply these advances in economics to patent law. As a result, expanding the analysis of the economic apects of patent law to include considerations of productive inefficiency provides new insight into the development of effective patent law.

A. *General Concerns*

Due to the limitations of managerial supervision, competition is vital to limiting productive inefficiencies. Unfortunately, patents often inhibit competition.[161] For instance, patents may provide exclusive rights to technology that is critical to competing in an industry, like the active ingredients in some pharmaceuticals.[162] Patents can also limit competition when they cover technology that is incorporated into an industry standard.[163] After a certain technology becomes part of an industry

160. WILLIAMSON, *supra* note 15, at 121.

161. *See, e.g.*, BURK & LEMLEY, *supra* note 51, at 8 ("[P]atents represent a significant departure from the norm of market competition. A patent gives its owner a legal right not only to prevent others from copying her idea but even the right to stop independent inventors from continuing to use ideas they developed themselves."). Often times, patents have little effect on competition. Indeed, many patents have little economic effect because they are never licensed or otherwise commercialized. *See infra* Subsection III.C.1. Other times, patents provide only short-lived protection from competition because competitors can develop non-infringing market substitutes. *See* Burk, *supra* note 51, at 1618 ("Unlike the true monopolist, patent holders may well face a marketplace containing a variety of substitutes for their product, and be forced to price their products competitively."); Gilbert, *supra* note 26, at 163 ("Patent protection does not guarantee that the inventor will be able to prevent competition from others, either legally by inventing-around the new technology, or illegally by infringing the patent."). Indeed, the U.S. Supreme Court recently held that "a patent does not necessarily confer market power" for antitrust purposes. Ill. Tool Works Inc. v. Indep. Ink, Inc., 547 U.S. 28, 44 (2006).

162. *See* CHRISTINA BOHANNAN & HERBERT HOVENKAMP, CREATION WITHOUT RESTRAINT: PROMOTING LIBERTY AND RIVALRY IN INNOVATION, at xv (2012) (describing the modern view of patents as property that set "boundary-based" restrictions on use); Burk, *supra* note 51, at 1618 (noting that, in some instances, patents may confer a virtual monopoly on holders, which monopoly generates inefficiencies common to monopolies). The market power created by patents may be higher in areas of rapid technological change. *See* Raymond Hartman et al., *Assessing Market Power in Regimes of Rapid Technological Change*, 2 INDUS. & CORP. CHANGE 317, 319 (1993).

163. Industry standards cover a wide variety of products, including mobile phones, semiconductors, and personal computers. *See* Mark A. Lemley, *Intellectual Property Rights and Standard-Setting Organizations*, 90 CAL. L. REV. 1889, 1893, 1903, 1946 (2002). These patents are often described as "'standards-essential' patents" or "SEPs." Jorge L. Contreras, *Standards, Patents, and the National Smart Grid*, 32 PACE L. REV. 641, 655 (2012). By definition, firms in a standards-based industry cannot avoid infringing SEPs. Because of the competitive problems that

standard, competitors must use the patented technology even though alternate technologies were available before the establishment of the industry standard.[164] Even patents on technologies that are not central to an industry and thus protect only one way of competing can affect rivalry by raising costs for competitors who accidentally infringe these patents.[165] For example, one firm may invest substantial resources in developing a technology only to learn later that the technology infringes a rival's patent. Because independent invention is not a defense to patent infringement,[166] the infringing firm may consider switching to a different technology to avoid patent liability. "Even when non-infringing alternatives are technologically possible, however, switching technologies" may be commercially infeasible.[167] Moreover, even if there are many potential substitutes for patented technology on the market, the first company to reach the market may enjoy a dominant position due to first mover effects. For example, although some drugs use similar active ingredients, the first one to reach the market may dominate for many years.[168]

As described earlier, competition is often critical to limiting productive inefficiencies.[169] As a result, when patents limit competition, they promote productive inefficiencies and thus reduce social welfare.[170] Therefore, policy makers should consider the effects of patents on productive

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can arise with industry standards, many standard-setting organizations seek to use private agreements to limit the capacity of patent owners to undermine competition. *See generally* Lemley, *supra*, at 1957–68 (suggesting changes to rules enacted by standard-setting organizations so as to provide clarification, specificity, and fairness).

164. *See* BOLDRIN & LEVINE, *supra* note 51, at 86 (describing how one firm can hijack an industry standard at the expense of the industry by "trying to collect fees from other chip makers that have successful designs"). Changing standards after they have been established can be expensive. *Id.* at 86–87.

165. Such patents are common. *See Ill. Tool Works Inc.*, 547 U.S. at 43 n.4; BOHANNAN & HOVENKAMP, *supra* note 162, at xv. In some instances, patents might not affect competition because competitors can "invent around" the patented technology, that is, deveop non-infringing alternatives. *See, e.g.*, 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, 1313 (2009) (providing statistics regarding the "[e]ase of inventing around" patents in various enumerated industries); Richard C. Levin et al., *Appropriating the Returns from Industrial Research and Development*, 3 BROOKINGS PAPERS ON ECON. ACTIVITY 783, 802–03 (1987).

166. BURK & LEMLEY, *supra* note 51, at 67 n.11.

167. *See* Hubbard, *supra* note 13, at 1931 (discussing difficulties in switching technologies); *see also* Jorge L.Contreras, *A Market Reliance Theory for FRAND Commitments and Other Patent Pledges*, UTAH L. REV. (forthcoming Spring 2015), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2309023.

168. *See, e.g.*, Gilbert, *supra* note 26, at 202 (discussing this phenomenon in the context of ACE-inhibitor drugs).

169. *See supra* Subsection II.C.1.

170. *See* Burk, *supra* note 51, at 1618 (arguing that patents generate inefficiencies similar to those create by monopolies and that those inefficiencies tend to generate higher prices, restrict supplies, and cause the inefficient allocation of resources); BURK & LEMLEY, *supra* note 51, at 8 ("So patents can not only encourage innovation, they can also interfere with it.").

inefficiencies in designing patent laws.[171] All things being equal, strengthening patent rights will insulate innovators from competition and thus foster productive inefficiency. Conversely, "[t]o the extent that competition increases, an increase in [productive efficiency] would be predicted."[172]

Although productive inefficiency has been overlooked in the development of modern patent law, it is particularly relevant today for at least three reasons. First, since the late 1970s patent rights in the United States have grown steadily stronger and stronger patent rights reduce competition to a greater extent.[173] For example, although both courts and the U.S. Patent and Trademark Office once considered software and business methods ineligible for patent protection, software and business method patents are common today following a favorable decision by the U.S. Court of Appeals for the Federal Circuit.[174] Although some aspects of U.S. patent protections have tempered in recent years,[175] U.S. law still provides the strongest form of patent protection in the world.[176] Importantly, during this period of increasing patent strength, policy makers and scholars have not considered the effects of changes to patent law on productive inefficiency but have instead focused only on traditional economic concerns.[177]

Second, productive inefficiency problems may be more pronounced among innovators than elsewhere in the economy. As economists Michele

171. *See* BURK & LEMLEY, *supra* note 51, at 8; LANDES & POSNER, *supra* note 12 at 294–96 (discussing factors impacting the scope of patent protection). In contrast to patent scholars, productive inefficiency economists have argued that "government regulation, by sheltering the firm from competitive pressure, may create an environment in which either managerial or non-managerial employees are only selectively rational, that is, [productively] inefficient." FRANTZ, *supra* note 17, at 202.

172. FRANTZ, *supra* note 17, at 116.

173. *See* LANDES & POSNER, *supra* note 12, at 13.

174. *See, e.g.*, State St. Bank and Trust Co. v. Signature Fin. Grp., Inc., 149 F.3d 1368, 1373, 1377 (Fed. Cir. 1998); 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, 578–79 (1999).

175. *See, e.g.*, Bilski v. Kappos, 130 S. Ct. 3216, 3229−30 (2010) (providing a narrow holding that the "petitioners' claims [were] not patentable processes because they [were] attempts to patent abstract ideas"). The Leahy-Smith America Invents Act weakened the rights provided by U.S. patent law in some respects. Pub. L. No. 112-29, 125 Stat. 284 (2011). For example, the Act expanded the universe of materials that could be used to invalidate a patent. *Compare* 35 U.S.C. § 102(a)(1) (2006) (denying patent protection if an invention was "known or used by others in this country, or patented or described in printed publication in this or a foreign country"), *with* 35 U.S.C. § 102(a)(1) (2012) (denying patent protection if an invention was "patented, described in a printed publication, or in public use, on sale, or otherwise available to the public before the effective filing date of the claimed invention"). Moreover, the America Invents Act expanded the defenses to patent infringement based on "prior use rights." Hubbard, *supra* note 13, at 1962.

176. *See* GLOBAL INTELLECTUAL PROP. CTR., U.S. DEP'T OF COMMERCE, CHARTING THE COURSE 30 (2d ed. 2014) (finding that the United States ranks first among twenty-five countries in "the strength of . . . environment[s] for patents, related rights, and limitations").

177. *See supra* notes 9–15 and accompanying text.

Boldrin and David Levine have observed, "not all innovators and managers are the clever, intelligent individuals usually assumed in economic theory. In the history of innovation, examples abound of innovators who, far from maximizing their monopoly profits, have achieved closer to the minimum."[178] Careful management often cannot offset these shortcomings because monitoring research and development activities and measuring related productivity are "both notoriously difficult (and perhaps counterproductive) managerial tasks."[179] Moreover, when obtaining patents, innovating firms often must retain legal services, and managers charged with monitoring those services face additional challenges, particularly if those managers lack legal training.[180] Likewise, technology startups often rely on outside investors with different goals than the entrepreneurs that manage the company, and those investors may be unable to monitor effectively the activities of the managing entrepreneurs.[181]

Third, concerns over productive inefficiency are particularly important today because of the effect of productive inefficiency on the competitiveness of firms in global markets. Firms suffering from productive inefficiencies fail to utilize their resources to maximum profit-making and thus cannot compete effectively against more productively efficient international rivals.[182] Unfortunately, although the competitiveness of U.S. firms in international markets is vital to U.S. economic prosperity, by many measures U.S. competitiveness has declined in recent years.[183] When U.S. patents limit competition in the United States

178. BOLDRIN & LEVINE, *supra* note 51, at 87. On the other hand, fostering maximum rationality may not be ideal for encouraging invention. Like other creative endeavors, conventionalism and reasonableness may undermine innovative thought processes.

179. Merges, *supra* note 21, at 28; *see* Sichelman, *supra* note 51, at 360–61 (describing the risks and costs associated with commercialization of an invention, including but not limited to: "costly and risky scientific testing, market testing, market research, and marketing").

180. *See* John R. Thomas, *Claim Re-Construction: The Doctrine of Equivalents in the Post-*Markman *Era*, 9 LEWIS & CLARK L. REV. 153, 168 (2005).

181. *See* Ted Sichelman & Stuart J.H. Graham, *Patenting by Entrepreneurs: An Empirical Study*, 17 MICH. TELECOMM. & TECH. L. REV. 111, 124 n.60 (2010) (noting the existence of a principal–agent problem when "the entrepreneur engages in investments to maximize both her pecuniary and non-pecuniary gains, while the investor is only interested in the former").

182. *See, e.g.*, CAVES & BARTON, *supra* note 19, at 2 (discussing the decline in competitiveness of U.S. manufacturing and arguing specifically that "U.S. productivity levels came to be matched and exceeded at the same time the superior quality and/or more innovative designs of some foreign manufactures became widely evident").

183. Hubbard, *supra* note 13, at 1914–17. For example, the World Economic Forum (WEF) measures competitiveness using an analysis of numerous factors related to competiveness, including the quality of education and training, the efficiency of labor and capital markets, infrastructure, technological readiness, business sophistication, and innovation. In 2007 and 2008, the United States topped the WEF competitiveness rankings. Thereafter, however, the United States began to drop in the rankings, slipping to second in 2009, fourth in 2010, fifth in 2011, and seventh in 2012. KLAUS SCHWAB, WORLD ECON. FORUM, GLOBAL COMPETITIVENESS REPORT 2012–2013, at 13 (2012); KLAUS SCHWAB, WORLD ECON. FORUM, GLOBAL COMPETITIVENESS REPORT 2010–2011, at 15 (2010); Kai Bucher, *US Competitiveness Ranking Continues to Fall; Emerging Markets Are Closing the Gap*, WORLD ECON. FORUM (Sept. 7, 2011), http://www.weforum.org/news/us

and increase productive inefficiency, they can undermine the competitiveness of U.S. firms in global markets.[184]

B. *Quantifying Productive Inefficiency from Patents*

As described above, many economists have empirically verified that increased competition can reduce productive inefficiencies.[185] Unfortunately, these economic studies did not explicitly consider the effect of patent protection on productive inefficiencies, but when patents limit competition the effects on productive inefficiency are likely to be similar to those identified by modern economists. Nevertheless, there are at least two further issues that warrant consideration in evaluating the magnitude of productive inefficiencies stemming from patent protection.

1. The Complex Effects of Patent Protection

When patents limit competition, they may increase productive inefficiency[186] and thus reduce social welfare. Patents, however, affect competition and social welfare in many other respects as well. In fact, patents can sometimes *increase* competition. For example, the protections of exclusive patent rights may encourage a technologically lagging firm or a new entrant to develop technology to compete with dominant incumbents.[187] Moreover, even when patents reduce competition, they can increase social welfare if the value of a new invention overshadows any costs stemming from reduced competition.[188] For example, when a patent prompts the discovery of a drug that cures an otherwise terminal illness, the patent likely increases social welfare even if it fosters productive inefficiencies. Similarly, a new manufacturing process may substantially increase a firm's productivity even if a patent on the process substantially affects competition.

Even though patents do not always limit competition, they often do so. Indeed, in order to generate meaningful incentives to invent, patents must

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competitiveness-ranking-continues-fall-emerging-markets-are-closing-gap. In 2013, matters improved slightly, with the WEF ranking the United States fifth in global competitiveness. KLAUS SCHWAB, WORLD ECON. FORUM, GLOBAL COMPETITIVENESS REPORT 2013–2014, at 15 (2013).

184. *See* CAVES & BARTON, *supra* note 19, at 111 ("Import competition (measured by imports' share of total supply) increases efficiency in industries whose domestic producers are concentrated."). However, international competition likely does not improve productive inefficiency as robustly as domestic competition. CAVES, *supra* note 19, at 12; *see also* PORTER, *supra* note 144, at 117–24 (arguing that domestic rivalry increases the competitiveness of firms in global markets); Hubbard, *supra* note 13, at 1942–43 (arguing that patents that undermine domestic rivalry can reduce the competitiveness of U.S. firms in global markets).

185. *See supra* notes 140–43 and accompanying text.

186. *See supra* notes 54–62, 161–70 and accompanying text.

187. Gilbert, *supra* note 26, at 174.

188. *See* LANDES & POSNER, *supra* note 12, at 379–80 (suggesting that patent holders may exploit society's scarce resources as efficiently as possible).

limit competition to a certain extent.[189] Discovering new inventions often requires substantial investment of time, effort, and money, and inventors and investors recover these expenditures by raising the prices for their goods and services.[190] When patents do not affect competition, competitors can charge lower prices than the patent owner for similar goods or services because the competitors do not need to recover any resources invested in the initial discovery.[191] In such a situation, the patent owner cannot recover the investment in the development of the new invention.

More generally, although patents can increase social welfare in some respects, they also can generate welfare-reducing productive inefficiencies.[192] Scholars and policy makers therefore should consider all costs and benefits when designing effective patent laws. At the very least, productive inefficiency is as relevant to the design of effective patent laws as allocative inefficiency.[193] Both productive inefficiency and allocative inefficiency are byproducts of patents that limit competition, and patent scholars universally agree that patents at least sometimes sufficiently impact competition to generate allocative inefficiencies. By the same logic, scholars and policy makers should also consider the effect of patents on productive inefficiency.

2. The Schumpeter–Arrow Debate

The argument that weakening patent protection can increase firm productivity raises issues addressed in a long-running debate among economists regarding the effect of competition on innovation. As described in more detail below, this debate has been largely inconclusive, and such indeterminacy in the economic literature might suggest that the effect of competition on productive efficiency is likewise indefinite. This Subsection rebuts this argument.

Joseph Schumpeter championed one side of the economic debate, arguing that competition undermines innovation.[194] Schumpeter asserted that in competitive markets firms might be reluctant to invest in projects

189. *See* Burk, *supra* note 51, at 1618 (noting that while "all patents represent some restraint on trade," patents are designed as such because "otherwise, individuals may not produce the good at all"); Lemley, *supra* note 54, at 996 ("Indeed, intellectual property rights must permit prices to rise above marginal cost in some cases if they are to have their intended effect of providing an incentive to create.").

190. *See* LANDES & POSNER, *supra* note 12, at 376–77.

191. *See id.* at 376 (noting variation between monopolistic and competitive pricing).

192. *See, e.g.*, Burk, *supra* note 51, at 1618 ("Patents are, in fact, specifically designed to create such [monopolistic] inefficiencies . . . .").

193. Some economists indicate, however, that limits on competition that do not trigger antitrust liability may nevertheless produce productive inefficiencies. CAVES & BARTON, *supra* note 19, at 111 (stating that the level of competition that maximizes productive efficiency occurs "below the range in which oligopolistic behavior appears to become significant").

194. BOHANNAN & HOVENKAMP, *supra* note 162, at 8 (describing Schumpeter's argument that monopoly tends to foster innovation while competition tends to retard it); Jonathan B. Baker, *Beyond Schumpeter vs. Arrow: How Antitrust Fosters Innovation*, 74 ANTITRUST L.J. 575, 578 (2007).

that will convey significant benefits to competitors, like basic scientific research.[195] Moreover, economic conditions in some industries also favor monopolies because of the benefits of economies of scale.[196] For example, smaller firms find it difficult to compete in the pharmaceutical industry in part because the cost of developing a new drug may be as high as $800 million.[197]

Economist Kenneth Arrow disagreed with Schumpeter, arguing that competition promotes innovation better than monopoly.[198] Oftentimes, Arrow noted, the monopolist faces little incentive to innovate because a new innovation would not increase the monopolist's market share.[199] Rather, the monopolist's sales of a new product may simply replace the monopolist's existing sales. As Steve Jobs observed in 2004, "[W]hat's the point of focusing on making the product even better when the only company you can take business from is yourself?"[200] With competition, firms are encouraged to innovate because sales of a highly innovative product can increase a firm's market share.[201] Moreover, firms may need to innovate to avoid losing market share to their innovating competitors. In the words of the Chief Executive Officer of Intel Corporation Andrew Grove: "Only the paranoid survive."[202]

Although the Schumpeter–Arrow debate has been one of the most intensely studied aspects of industrial organization, economists have not been able to crown a clear victor.[203] Indeed, numerous factors impact the

195. *See* BOHANNAN & HOVENKAMP, *supra* note 162 , at 8 (positing that under Schumpeter's paradigm, competition left firms with too little to invest in substantial innovation); Baker, *supra* note 194, at 578 ("[F]irms with a strong pre-existing market position, including monopolists, may be more willing to pursue R&D if, by virtue of their head start, they have less fear that rivals, lacking their installed base and reputation, would be able successfully to market products that emulate their new ideas "); *see also* Gilbert, *supra* note 26, at 175 ("The incentive to invest in R&D is low if competition post-invention would dissipate all or most of the profits.").

196. Gilbert, *supra* note 26, at 186. Monopolies may also enjoy advantages in raising capital to invest in research and development. *Id.*

197. BOLDRIN & LEVINE, *supra* note 51, at 212.

198. BOHANNAN & HOVENKAMP, *supra* note 162 , at 8 ("Arrow observed that competitors have more to gain from innovating, and much more to lose from failing to do so."); Baker, *supra* note 194, at 578 (stating that Kenneth Arrow provided an alternative theory characterized by the logic that "competition rather than monopoly promotes innovation").

199. Baker, *supra* note 194, at 578.

200. Tim Carmody, *Why Tim Cook Is the Best Choice to Run Apple*, WIRED (Aug. 25, 2011, 8:41 AM), http://www.wired.com/business/2011/08/why-tim-cook/.

201. *See* Gilbert, *supra* note 26, at 165 (noting that under Arrow's paradigm, competitive firms can attain a higher differential return if the competitive firm captures the same benefit from innovation as the monopolist); *id.* at 179 ("Monopolies that are protected from innovation competition are reluctant to innovate because they merely replace one profit flow with another, while new competitors capture the entire benefit of an innovation.").

202. *See* ANDREW S. GROVE, ONLY THE PARANOID SURVIVE 3 (1996).

203. *See* WILLIAMSON, *supra* note 15, at 176–77 ("An 'optimum' degree of competition, which holds across all industries and at all times, for promoting technical progress cannot be established by appeal to either theoretical argument or empirical analysis."); Baker, *supra* note 194, at 577 ("While economists widely accept that competition encourages firms to improve product attributes

effect of market structure on innovation, including the nature of the innovation (product or process) and the extent to which the innovation differs from existing technology.[204] Empirical analyses have not been able to cut through this theoretical morass, as numerous studies on the effects of competition on innovation have been largely inconclusive.[205] One scholar reviewing the literature concluded: "There is little evidence that there is an optimal degree of competition to promote [research and development]."[206]

One might argue that the indeterminacy of the Schumpeter–Arrow debate undermines the assertion that patents that limit competition foster productive inefficiency. For firms focusing on the development of new products and services, a more productively efficient firm likely will more often succeed in innovating. If competition does not promote innovation for these firms, however, how can it produce the same results under the guise of productive efficiency?

Such a critique of the effect of competition on productive inefficiency is misplaced for two reasons. First, the indeterminacy of the Schumpeter–Arrow debate does not demonstrate the invalidity of Schumpeter's argument that monopolists capture the benefits of innovation or Arrow's assertion that firms innovate out of fear of losing market share. Rather, the debate is unresolved because Schumpeter and Arrow identified countervailing concerns and neither uniformly predominates. By

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closely related to price, economists have not been so quick to say that competition encourages innovation."); Gilbert, *supra* note 26, at 195 ("The economic model of innovation competition does not establish a clear favorite model for empirical analysis."); *id.* at 161–62.

204. *See* Gilbert, *supra* note 26, at 165–68, 187. Some of the economic scholarship regarding the Schumpeter–Arrow debate unfortunately relies upon unrealistic simplifications regarding patent law. For instance, some economists assert that competition undermines innovation because innovators are unable to prevent competitors from piggybacking off innovators' investments in developing new technologies. *Id.* at 164. In actuality, of course, innovators can often prevent such freeriding by obtaining patent protection and other intellectual property rights. Conversely, other economists contend that monopolies undermine innovation if the "innovator enjoys perfect and perpetual exclusive property rights to its invention." *Id.* Patent rights, however, are not perpetual nor do they "perfectly" eliminate all benefits to competitors from the invention. Brett M. Frischmann & Mark A. Lemley, *Spillovers*, 107 COLUM. L. REV. 257, 290–91 (2007); Gilbert, *supra* note 26, at 202. Economists have noted other important considerations omitted from earlier economic analyses of the effects of market structure on innovation. For example, monopolies may be helpful in developing human capital that later matures in competitive markets. Gilbert, *supra* note 26, at 184. On the other hand, competition may support the pursuit of more diverse research projects than is possible under monopoly conditions. *Id.* at 185.

205. *See* WILLIAMSON, *supra* note 15, at 180–82 (collecting studies); Douglas H. Ginsburg & Joshua D. Wright, *Dynamic Analysis and the Limits of Antitrust Institutions*, 78 ANTITRUST L.J. 1, 4 (2012) (finding that "it is not surprising that the empirical literature attempting to link market structure and product market competition . . . to innovation is inconclusive"); *see also* Gilbert, *supra* note 26, at 187–204 (collecting and analyzing numerous empirical studies). One reason that empirical studies have been unable to reach decisive conclusions is that the relationship between innovation and market structure runs both ways: one can analyze both whether market structure affects innovation and whether innovation affects market structure. *See* Gilbert, *supra* note 26, at 195–96.

206. Gilbert, *supra* note 26, at 206.

identifying another benefit to competition, productive inefficiency analysis adds new support for Arrow's position but does not alter the underlying nature of the trade-off that lies at the heart of the debate.[207] Second, the Schumpeter–Arrow debate does not obviate consideration of productive inefficiency because the debate focuses only on innovation, and productive inefficiencies can arise in parts of firms that are only indirectly related to the development of new products and services. For example, even when increased competition fails to encourage pharmaceutical companies to develop more drugs, it might encourage them to embrace superior manufacturing techniques.[208] When competition does not increase innovation but nonetheless increases productive efficiency, social welfare increases.[209] Thus, despite the indeterminacy of the Schumpeter–Arrow debate, scholars and policy makers should consider the effect of patents on productive inefficiency when designing patent regimes. The next Subsections explore three unresolved debates in patent law that would benefit from such a consideration of productive inefficiency.

C. *Promoting Commercialization*

Productive inefficiency analysis helps to clarify a long-running, contentious debate in patent law regarding the commercialization of patented inventions.

1. The Commercialization Problem

Every year, hundreds of thousands of inventions are patented,[210] but many of them are never commercialized. By one estimate, "[a]bout half, probably more, of all patented inventions in the United States are never commercially exploited."[211] Without a doubt, "[m]any of these undeveloped inventions are commercially worthless,"[212] such as U.S. Patent No. 6,293,874, which covers a "User-Operated Amusement Apparatus for Kicking the User's Buttocks."[213] However, many underdeveloped inventions are likely valuable, and the insufficient commercialization of these inventions represents lost opportunities for increasing social welfare.[214] Standing alone, an invention does not improve social welfare unless it ultimately spurs the development of commercial products or services.[215] Commercialization problems can also arise from

207. Indeed, in a situation in which the considerations identified by Schumpeter and Arrow are in equipoise, an analysis of productive efficiency may provide a basis for favoring competition.

208. *See supra* notes 2–5 and accompanying text.

209. *See supra* Section II.B.

210. U.S. PATENT & TRADEMARK OFFICE, U.S. PATENT STATISTICS, CALENDAR YEARS 1963–2013, http://www.uspto.gov/web/offices/ac/ido/oeip/taf/us_stat.pdf (last visited Aug. 11, 2014).

211. Sichelman, *supra* note 51, at 343–44 (discussing empirical data).

212. *Id.* at 343.

213. U.S. Patent No. 6,293,874 (filed Jan. 4, 2000).

214. *See* Abramowicz, *supra* note 43, at 1069 (discussing problems of underdevelopment of patented inventions); Sichelman, *supra* note 51, at 363–64.

215. *See* Sichelman, *supra* note 51, at 354.

delayed commercialication of inventions. *Ceteris paribus*, obtaining benefits earlier is better for society than obtaining those benefits later.

At least two related factors substantially contribute to the delayed or forgone commercialization of patented inventions. First, U.S. patent law encourages inventors to patent early in the innovation process, well before the inventor has taken many significant steps towards commercialization.[216] Because patents issue to the first inventor to file a patent application, inventors must patent as soon as possible or risk losing the patent to another inventor.[217] Indeed, multiple independent inventors are oftentimes working simultaneously to discover the same invention.[218] Because independent invention is not a defense to patent infringement, the second inventor to file a patent application generally will be unable to profit from the invention.[219] Patent law further encourages inventors to patent an invention as soon as possible, because commercialization—either by the inventor or a third party—can preclude the inventor from obtaining a patent. Specifically, U.S. patent law bars an inventor from obtaining a patent if a product incorporating the invention has been sold anywhere in the world before the inventor files for a patent.[220] Unfortunately, firms that are best equipped to invent quickly may not be best suited to commercialize, particularly when successful commercialization requires sales on a large scale to be profitable.[221] An inventing firm might license or assign their inventions to firms better equipped to commercialize them, but

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216. Christopher A. Cotropia, *The Folly of Early Filing in Patent Law*, 61 HASTINGS L.J. 65, 72 (2009); *see also* 35 U.S.C. § 102 (2012) (pressuring early patent filings); Sichelman, *supra* note 51, at 350–51 ("[B]ecause of the reward theory's preference for early patenting and the weak disclosure standards applied by the Patent Office, patents are granted at the initial stages of conception, which . . . can lead to the significant underdevelopment of inventions."(footnote omitted)).

217. Recently, the United States shifted from a system that awarded patent rights only to the first person to discover an invention to a system that awards patent rights only to the first inventor to file a patent application. William Hubbard, *Competitive Patent Law*, 65 FLA. L. REV. 341, 367 (2013).

218. Mark A. Lemley, *The Myth of the Sole Inventor*, 110 MICH. L. REV. 709, 712 (2012) ("The overwhelming majority of inventions, including the overwhelming majority of so-called 'pioneering' inventions, are in fact developed by individuals or groups working independently at roughly the same time.").

219. *See supra* notes 166–68 and accompanying text; Gregory N. Mandel, *The Public Perception of Intellectual Property*, 66 FLA. L. REV. 261 (2014) ("[P]atent law prohibits a later independent inventor from obtaining patent protection on the same subject matter as an earlier inventor."). An inventor who fails to patent but commercializes her invention may be able to continue to practice the invention if she qualifies as a prior user under 35 U.S.C. § 273.

220. *See* 35 U.S.C. § 102(a). In some cases, the inventor may be able to obtain a one-year grace period for this bar. *Id.* § 102(b).

221. *See* WILLIAMSON, *supra* note 15, at 205–06 (hypothesizing an efficient procedure to mitigate the "early stage innovative disabilities of large size"); Sichelman, *supra* note 51, at 367 ("[T]here is no reason to expect that inventors who win the race to patent will be the best commercializers.").

productive inefficiencies and transaction costs may prevent inventors from executing the transfer of rights.[222] Indeed, highly innovative firms sometimes refuse to sell or license their patents until they are facing bankruptcy.[223]

The second factor that contributes to the underdevelopment of patented inventions is that the steps towards commercialization that follow early patenting are uncertain and expensive.[224] For instance, to commercialize an invention an inventor often must develop a prototype, a manufacturing process, and distribution channels. Innovators also frequently perform market experimentation, including "studies to assess the effectiveness of the invention, testing commercially the public's demand for the invention, and informing customers or others about the invention,"[225] and the cost of this testing can be significant.[226] Indeed, by some estimates the cost of commercializing a patented invention substantially exceeds prepatented invention expenses.[227] Unfortunately, even an inventor who is willing to invest in commercialization may fail to produce a commercially successful product or service because there is a particularly high probability of failure in developing innovative products.[228] Facing these challenges, many patent owners do not even attempt to commercialize their inventions, and opt instead to profit from their patents through litigation.[229]

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222. *See supra* notes 61–62 and accompanying text.

223. For example, Kodak did not sell its portfolio of patents until after it declared bankruptcy in early 2012. John Brodkin, *Kodak Declares Bankruptcy, Presses on with Patent Suits, Digital Strategy*, ARS TECHNICA (Jan. 19, 2012, 10:45 AM), http://arstechnica.com/gadgets/2012/01/kodak-declares-bankruptcy-presses-on-with-patent-suits-digital-strategy/; Andrew Martin, *Kodak to Sell Digital Imaging Patents for $525 Million*, N.Y. TIMES (Dec. 19, 2012), *available at* http://www.nytimes.com/2012/12/20/business/kodak-to-sell-patents-for-525-million.html. Similarly, Nortel Networks declared bankruptcy in 2009, and subsequently sold its portfolio for $4.5 billion. Steven Church et al., *Apple Joins Microsoft, RIM in $4.5 Billion Buy of Nortel Patents*, BLOOMBERG (July 1, 2011, 12:18 PM), http://www.bloomberg.com/news/2011-07-01/nortel-sellspatent-portfolio-for-4-5-billion-to-group.html. *See generally* CLAYTON M. CHRISTENSEN, THE INNOVATOR'S DILEMMA (1997) (analyzing the factors that lead technologically successful firms to fail).

224. *See* WILLIAMSON, *supra* note 15, at 192 (providing that at the early stages of innovative development, modest resources are frequently sufficient, however "later stage development often incurs much greater expense").

225. Abramowicz, *supra* note 43, at 1099.

226. Abramowicz & Duffy, *supra* note 65, at 339–40; Sichelman, *supra* note 51, at 351("Often the capital required for the market testing and product commercialization phase is tremendous.").

227. Sichelman, *supra* note 51, at 371–72 ("[P]ost-invention development and commercialization expenses dwarf pre-invention expenses in nearly all industries.").

228. *Id.* at 361 & n.116 (collecting numerous supporting authorities); *see also* Abramowicz, *supra* note 43, at 1101 ("The problem of inventors' not engaging in sufficient commercial experimentation is particularly severe for inventions that have a small probability of large commercial success and a great probability of failure. Once an invention falls into the public domain, someone considering commercializing the invention faces the prospect of bearing the entire cost of the experimentation if it fails.").

229. Abramowicz, *supra* note 43, at 1073 (noting that patent owners may forego exercising their "development option" in favor of their "litigation option").

2. Existing Proposals

Although many scholars have recognized the importance of commercializing patented inventions, these scholars differ sharply in their proposals for increasing commercialization. Importantly, they also disagree on the extent to which exclusive rights that limit competition will encourage commercialization.

One group of scholars asserts that strong patent rights best promote the commercialization of inventions. The most influential of these analyses is Edmond Kitch's "prospect theory" of patent law.[230] Noting that the traditional justification of patent law posits that a patent "enables an inventor to capture the returns from his investment in the invention," Kitch argued that this "reward theory [of patent law] offers an incomplete view of the functions of the patent system" because it fails to recognize the effect of patent rights on postinvention commercialization efforts.[231] In explaining these effects, Kitch famously analogized patents to mineral prospects.[232] Kitch noted that awarding exclusive rights to extract minerals in a location encourages individuals to invest thereafter the significant capital required for successful mining operations.[233] Kitch asserted that patents similarly promote the subsequent commercialization of inventions by awarding to patentees the exclusive "opportunity to develop a known technological possibility . . . . shortly after its discovery."[234] Kitch noted that without patent protection, an innovator might be reluctant to invest in commercial development because the fruits of that labor may "produce unpatentable information appropriable by competitors."[235] Kitch therefore concluded that the prospect function of patents justifies awarding patents well before commercial exploitation is feasible.[236] Moreover, Kitch asserted that the prospect function of patents is a "significant, if not the predominant, function of the American patent system as it has operated in fact."[237]

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230. *See* Edmund W. Kitch, *The Nature and Function of the Patent System*, 20 J.L. & ECON. 265, 266 (1977) ("[T]he view of the patent system offered here conceives of the process of technological innovation as one in which resources are brought to bear upon an arrary of prospects, each with its own associated sets of probabilities of costs and returns."). *But see* Abramowicz, *supra* note 43, at 1070 ("[O]ur patent system is actually not much of a prospect system.").

231. Kitch, *supra* note 230, at 266.

232. *Id.* (arguing that the mineral claim industry serves as a close analog to the patent industry).

233. *Id.* at 274.

234. *Id*. at 266.

235. *Id.* at 276; *accord* Abramowicz, *supra* note 43, at 1101 (noting that if a patent succeeds, the original patent holder will likely have to fend off third parties seeking to enter the market and claim some portion of the market share that the original holder enjoyed).

236. Kitch, *supra* note 230, at 267.

237. *Id.* For example, application of patent law to the pharmaceutical industry exhibits prominent prospect theory features. Abramowicz, *supra* note 43, at 1095; Mark A. Lemley, *Ex Ante*

Some more recent scholars have embraced Kitch's argument that exclusive rights promote commercialization,[238] while tempering prospect theory with a measure of additional competition. For example, Michael Abramowicz recommends extending the duration of some patents to encourage commercialization.[239] Abramowicz recognizes, however, that patent term extensions could generate additional costs, most notably a deadweight loss from allocative inefficiency: "If a patent term is too short, the patentee might have socially insufficient incentives to develop the patent by engaging in nonpatentable research and commercialization activities, but if it is too long, excessive deadweight loss will result."[240] To balance these considerations, Abramowicz recommends limiting patent term extensions to those likely to foster commercialization. Under Abramowicz's proposal, extensions should be offered at the end of a patent's normal term "when the additional development activities an extended term would enable and the costs of extended protection should be clear."[241] Moreover, to reduce the deadweight loss from allocative inefficiency, Abramowicz proposes apportioning patent term extensions through auctions.[242] Abramowicz contends that such auctions with multiple bidders would provide sufficient competitive elements to ensure that the social benefits of the proposed patent term extensions would exceed the deadweight losses from allocative inefficiencies.[243]

Other scholars likewise assert that hybrid solutions can best promote the commercialization of patented inventions but advocate for even stronger competitive dimensions.[244] Ted Sichelman recommends that U.S.

Versus Ex Post Justifications for Intellectual Property, 71 U. CHI. L. REV. 129, 141 (2004). In part due to the requirements of the U.S. Food and Drug Administration, commercializing a pharmaceutical invention is enormously expensive. Drug companies would be reluctant to invest in such commercialization without the protection of exclusive patent rights.

238. *See, e.g.*, F. Scott Kieff, *Property Rights and Property Rules for Commercializing Inventions*, 85 MINN. L. REV. 697, 703 (2001) (arguing that strong exclusive rights are "necessary to facilitate investment in the complex, costly, and risky commercialization activities required to turn nascent inventions into new goods and services").

239. *See* Abramowicz, *supra* note 43, at 1098.

240. *Id.* at 1106. Indeed, because inventors often race to obtain patent rights, an inventor will often patent long before commercialization is possible, which will "result in shorter effective patent terms." *Id.*

241. *Id.* at 1108.

242. *See id.* at 1108–20.

243. *See id.* at 1109 (arguing that competition between bidders in auctions will increase incentives to invest in future inventions and that the small windfalls represented by term extensions would be "part of the incentive to create").

244. For example, Dan Burk and Mark Lemley have argued that prospect theory should be applied selectively to certain industries, with patenting in the early stages of technical development most appropriate for pharmaceutical inventions. Dan L. Burk & Mark A. Lemley, *Policy Levers in Patent Law*, 89 VA. L. REV. 1575, 1616 (2003) ("The prospect vision of patents maps most closely onto invention in the pharmaceutical industry."). Burk and Lemley caution, however, against early

patent law be amended to create a new form of intellectual property right, which he terms a "commercialization patent."[245] Importantly, "a commercialization patent not only would provide a negative right to exclude others from making and selling the same or equivalent products, but also would include an affirmative equitable and legal right to its holder to make and sell the product."[246] In an infringement suit against the owner of a commercialization patent, the owner of a traditional invention patent would be able to obtain only "a low, but fairly reasonable, fixed royalty rate."[247] While maintaining some exclusivity for the owner of the traditional patent, commercialization patents would thus foster substantial competition between the owner of the traditional patent and the recipient of a commercialization patent.[248] Moreover, because a commercialization patent would grant narrow protection restricted to the product described in the particular grant, other innovators could obtain their own commercialization patents to develop different products from the underlying invention.[249] Sichelman asserts that the expanded competition made possible by commercialization patents would reduce the deadweight loss from allocative inefficiency caused by traditional patent rights.[250]

Other approaches to commercialization go further than Sichelman's approach in promoting competition. For example, some scholars advocate for strengthening patenting requirements, so that patents would become available at a time less removed from commercialization, thereby moving the "inventor further down the development path before examination," while concomitantly giving "the inventor a clearer picture of the possible commercial value of the invention" before obtaining a patent.[251] Other scholars propose strengthening the experimental-use defense to patent infringement to allow competitors to begin the lengthy process of commercializing a patented invention during the term of the patent, so that robust commercial competition could commence immediately upon the

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patenting for isolated segments of human DNA due to concerns that overlapping patent claims would discourage further innovation. *Id.* at 1624–27.

245. Sichelman, *supra* note 51, at 345–46.

246. *Id.* at 346 (emphasis omitted). In contrast, traditional patent rights provide only the negative rights to prevent infringers from making, using, offering to sell, selling, or importing into the United States a patented invention. *See, e.g.*, 35 U.S.C. § 271(a) (2012).

247. Sichelman, *supra* note 51, at 346.

248. To ensure that inventors retain sufficient incentives to invent, Sichelman recommends "giv[ing] the invention patent holder a head start to commercialize its invention, for example, three years after issuance, extended for regulatory and Patent Office delays during the commercialization process." *Id.* at 406.

249. *See id.* at 401 (arguing that commercialization patents "should be limited exactly to the product described in the specification" because the justification for such patents is to "encourage the development of specific products not currently in the marketplace" (emphasis omitted)).

250. *Id.* at 408.

251. *E.g.*, Cotropia, *supra* note 216, at 119–20.

patent's expiration.[252] Some foreign patent laws go even further by entitling innovators to compulsory licenses to uncommercialized patents.[253]

3. Incorporating Productive Inefficiency Analysis

For decades, accomplished and insightful scholars have debated—with no clear victor—the best approach to fostering the commercialization of patented inventions. The reason for the lack of resolution is that a difficult balancing of costs and benefits lies at the heart of the debate and competition potentially impacts both sides of this balancing. In analyzing this trade-off, scholars have relied on traditional neoclassical economics. For example, prospect theorists assume that inventors are profit maximizers and argue that freeriding by competitors can prevent inventors from pursuing profitable commercialization opportunities.[254] Other scholars argue that the same reduction in competition that protects incentives to commercialize will create deadweight losses through allocative inefficiencies.

While insightfully juggling neoclassical economic concerns, these scholars have omitted from their analyses considerations of productive inefficiency. For example, although Kitch notes that "many important inventions are patented early in their development," he fails to consider whether the early patenting of the invention might have *delayed* commercialization.[255] Similarly, while Abramowicz recognizes the importance of competition in the structure of his auctions for patent term extensions, he fails to consider whether competition is also needed during the commercialization phase to reduce productive inefficiency. Even scholars who generally embrace competition have not realized the full scope of the benefits stemming from competition. For instance, in arguing for some exclusive rights to commercialize, Sichelman asserts that strong

252. *See, e.g.*, Hubbard, *supra* note 13, at 1953–57 (discussing the experimental use defense).

253. *See* Abramowicz, *supra* note 43, at 1107; Sichelman, *supra* note 51, at 394; *see also* Paris Convention for the Protection of Industrial Property art. 5, Mar. 20, 1883, 828 U.N.T.S. 305 (revised at Stockholm July 14, 1967) (describing compulsory patent licenses). Such laws are rarely invoked. Sichelman, *supra* note 51, at 395; *see, e.g.*, Vikas Bajaj & Andrew Pollack, *India Orders Bayer to License a Patented Drug*, N.Y. TIMES (Mar. 12, 2012), http://www.nytimes.com/2012/03/13/business/global/india-overrules-bayer-allowing-generic-drug.html (reporting that the government of India granted a compulsory license for a patented cancer drug because the price charged by the patent owner was "unaffordable to most of the nation").

254. *See* Kitch, *supra* note 230, at 276 ("[T]he patent owner has an incentive to make investments to maximize the value of the patent without fear that the fruits of the investment will produce unpatentable information appropriable by competitors."). Some information related to commercialization can be protected by improvement patents or other forms of intellectual property, like trade secrets or copyrights. *See* Abramowicz, *supra* note 43, at 1091. Likewise, first mover effects can prevent competitors from successfully profiting from another firm's commercialization efforts. *Id.* Many of the fruits of efforts to commercialize, however, are not protectable by these mechanisms. Sichelman, *supra* note 51, at 373.

255. *See* Kitch, *supra* note 230, at 271.

patent rights often will fail to promote commercialization because inventors may not be effective commercializers and because transaction costs may prevent inventors from transferring their rights to superior commercializers.[256] Patent-related productive inefficiencies may make matters worse by undermining inventors' effectiveness in both commercialization and licensing.[257]

In fact, productive inefficiencies are likely to arise during the commercialization of a patented invention, particularly if exclusive rights insulate a commercializing firm from competition. Employees involved in commercialization may be reluctant to develop new products or services, in part because it takes effort "to convert knowledge from a feeling or an idea into a form that is useful for the firm."[258] Conserving effort and favoring old habits, employees may be slow to pursue opportunities to commercialize inventions. Moreover, employees may be disinclined to attempt to commercialize an invention due to loss aversion, status quo bias, and hyperbolic discounting because the chance of failure is often high and the costs of a failed commercialization effort are typically easier to measure than the forgone benefits of a new product that is never developed.[259] Management can easily quantify the time and money invested in the development of a new product and compare those expenses to the profits of a new product. In contrast, when an employee delays working to commercialize a new invention, management frequently will be unable to quantify the impact on the firm's profits because of the substantial uncertainty regarding the cost of commercialization, the likelihood of success, and the amount of profits a new product would generate if successful.[260] Employees with responsibilities related to new product development therefore may not optimally exert themselves, particularly when existing products continue to provide alternate opportunities.[261] Instead, employees tasked with commercializing an invention may wait until other technological or commercial developments reduce the risk of commercializing the invention.[262] Even employees working on tasks tangentially related to new product development, like

256. Sichelman, *supra* note 51, at 368–70.

257. *See* Buccafusco & Sprigman, *supra* note 15, at 4, 34 (arguing that cognitive biases will hamper patnet licensing); Heller & Eisenberg, *supra* note 32, at 701 (noting the downstream effects of cognitive biases on commercialization).

258. FRANTZ, *supra* note 17, at 97.

259. *See supra* notes 83–86, 159 and accompanying text.

260. Abramowicz, *supra* note 43, at 1075; Sichelman, *supra* note 51, at 361.

261. BOLDRIN & LEVINE, *supra* note 51, at 266 ("[W]hen someone can sell at high prices because of legal protection from imitators, he or she will not expend much effort looking for better or cheaper ways to do things.").

262. *See* Abramowicz, *supra* note 43, at 1075–78 (describing the benefits of waiting to commercialize an invention).

marketing, may exhibit high levels of productive inefficiency due to the comparative ease of quantifying failed commercialization efforts.[263]

Scholars and policy makers thus should consider the impact of productive inefficiency in crafting laws that foster the commercialization of patented inventions. Considerations of productive inefficiency will not change the nature of the trade-off that underlies commercialization policy, but productive inefficiency analysis provides additional support for arguments in favor of greater competition, like Sichelman's, because competition reduces productive inefficiency. Even if die-hard prospect theorists are correct that competition reduces some incentives to commercialize, competition can increase the *responsiveness* of firms to incentives, so that smaller incentives to commercialize paradoxically may produce greater effect.[264]

D. *Patent Scope*

Productive-inefficiency analysis also provides new insights into an unresolved debate regarding the appropriate scope of patent protection. The scope of a patent largely depends on a patent's "claims," which are numbered sentences at the end of the patent (and the patent application before the patent issues) that "particularly point[] out and distinctly claim[] the subject matter which the inventor or a joint inventor regards as the invention."[265] Inventors often strive to obtain patents with expansive claims because broader exclusive rights are more valuable to the inventor. Broad patent claims are more likely to be infringed by competitors, and therefore may allow the patentee to enjoy higher profits during the term of the patent. However, patent law prevents inventors from obtaining exclusive rights that exceed the scope of the inventors' discoveries. For example, an inventor must describe the invention in sufficiently clear, concise, and exact terms so as to enable any person skilled in the technological field to which the patent pertains to practice it, and patent claims cannot exceed the scope of enablement.[266] Nevertheless, numerous other doctrines allow inventors to obtain patent protection that exceeds the scopes of their inventive efforts.[267] Moreover, patent examiners and courts

263. Furthermore, the uncertainty related to potential commercialization limits the capacity of management to reduce employees' productive inefficiencies. *See supra* Subsection III.C.2.

264. *See* Gerla, *supra* note 17, at 236 ("To the extent that rivalry curbs [productive inefficiencies] in firms, it can serve to facilitate the creation and commercial exploitation of innovations." (footnote omitted)).

265. 35 U.S.C. § 112(b) (2012).

266. 35 U.S.C. § 112(a). Such disclosure is often described as "the *quid pro quo* of the right to exclude." Kewanee Oil Co. v. Bicron Corp., 416 U.S. 470, 484 (1974).

267. Sichelman, *supra* note 51, at 350. For example, the U.S. Patent and Trademark Office and courts assess only whether a person of ordinary skill in the relevant technological field could practice the invention "without undue experimentation," thereby granting patent examiners and courts substantial discretion in assessing whether the inventor has satisfied the enablement

are systematically biased in favor of supporting inventors' efforts to obtain broad patent protection. The U.S. Patent Office requires patent examiners to grant patent applications unless an examiner can demonstrate that a patent should not issue. Similarly, courts hold patents valid unless a challenger proves otherwise by clear and convincing evidence.[268]

Scholars disagree regarding the effect of awarding patents of such broad scope. Some scholars consider broad patents to be problematic because they raise the cost of developing improvements to existing, patented technology.[269] Prospect theorists disagree, arguing that awarding inventors broad patent rights promotes innovation: "This puts the patent owner in a position to coordinate the search for technological and market enhancement of the patent's value so that duplicative investments are not made and so that information is exchanged among the searchers."[270]

Productive-inefficiency analysis cautions against awarding patents with scopes substantially exceeding their disclosures. Insulated from competition, the owner of such a broad patent may ineffectively develop the patent's full scope. Even if a broad patent discourages duplicative research efforts, the patent owner's efforts may suffer from substantial productive inefficiencies regarding the development of goods and services that fall within the scope of the patentee's exclusive rights but outside of the patent's disclosure. In many cases, inventors are likely to focus their subsequent research and commercialization efforts on the aspects of the invention disclosed in the patent description and not on uses of the invention that are far removed from the inventor's prepatenting activities.[271] Reducing the wasted costs from duplicative efforts is not per se more important than improving the quality of those efforts. Indeed, as an

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requirement. *In re* Wright, 999 F.2d 1557, 1561 (Fed. Cir. 1993) (internal quotation marks omitted). Also, the level of scrutiny applied to a patent application appears to depend substantially upon which patent examiner is working on the patent. *See* Douglas Lichtman, *Rethinking Prosecution History Estoppel*, 71 U. CHI. L. REV. 151, 155, 170 (2004) (noting that patent examiners "differ sharply in terms of their tendency to instigate claim language alterations"). Another doctrine that allows inventors to obtain patents that substantially exceed the scope of the disclosed invention is the doctrine of equivalents, which extends patent protection to "equivalent" technologies that fall outside of the literal scope of the patent claims. William R. Hubbard, *Efficient Definition and Communication of Patent Rights: The Importance of Ex Post Delineation*, 25 SANTA CLARA COMPUTER & HIGH TECH. L.J. 327, 347–48 (2009). A patent applicant also may strategically draft an unclear claim that "enables the examiner to adopt a narrow, valid construction while also allowing the patentee to argue a broad, but invalid, construction in a later patent infringement dispute." *Id.* at 346.

268. *See, e.g.*, Zenith Elecs. Corp. v. PDI Commc'n Sys., Inc., 522 F.3d 1348, 1363 (Fed. Cir. 2008). Moreover, patents are statutorily presumed to be valid. *See* 35 U.S.C. § 282; Sean B. Seymore, *The Presumption of Patentability*, 97 MINN. L. REV. 990, 995 (2013).

269. *See* Kitch, *supra* note 230, at 268 n.9; Merges & Nelson, *supra* note 11, at 870.

270. Kitch, *supra* note 230, at 276.

271. *See* Merges & Nelson, *supra* note 11, at 873 (arguing that inventors have the tendency to focus on past experience).

empirical matter, firms often fail to develop improvements to patented technology until threatened by outside competition.[272]

This concern is particularly salient regarding patents on chemical compounds. To obtain a patent for a new chemical compound, an inventor must show both that the compound is new and that the compound is "useful."[273] Patents cannot issue for new compounds if the patentee is merely studying the compound with the goal of discovering a use.[274] The typical justification for this rule is that allowing a patent on a compound before identifying a use for the compound would prevent others from researching the uses of the compound. As the U.S. Supreme Court stated in *Brenner v. Manson*, until a new compound is "shown to be useful, the metes and bounds of that monopoly are not capable of precise delineation. It may engross a vast, unknown, and perhaps unknowable area."[275] Once an inventor discovers a use for the compound, however, the patent applies to *all* uses of the compound, even those uses that are unrelated to the use identified by the patentee in satisfying the utility requirement.[276] Consistent with prospect theory, a patent on a new compound with many uses thus may provide an inventor with exclusive rights to uses of the compound that the inventor has not disclosed or discovered.

Productive inefficiency analysis identifies a problem with awarding broad patents on chemical compounds that extend to undiscovered uses. Although a patentee might investigate alternate uses of a compound (or license others to do so), such activities are less likely because the patent protects the patentee from competition regarding those alternate uses and thus exacerbates productive inefficiencies. Indeed, patent owners are more likely to focus on uses related to those already identified in the patent. For compounds with few alternate uses, patents covering undisclosed uses likely will not significantly affect productive inefficiency. But many compounds have substantial alternate uses, and the harm to society from the delayed innovation regarding such uses may be substantial.[277] For these compounds, tailoring the patentee's exclusive rights more closely to the uses actually disclosed in the patent may maximize social welfare.[278]

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272. *Id.* at 872.

273. 35 U.S.C. § 101 (2012).

274. *See, e.g.*, *In re* Fisher, 421 F.3d 1365, 1373–74 (Fed. Cir. 2005) (declining to award patent protection for "research intermediates").

275. 383 U.S. 519, 534 (1966).

276. *See* 35 U.S.C. § 271 (2012).

277. BOLDRIN & LEVINE, *supra* note 51, at 233 (noting that "[m]onopolies innovate as little as possible and only when forced to . . . ."); Merges & Nelson, *supra* note 11, at 852; *see, e.g.*, Dawson Chem. Co. v. Rohm & Haas Co., 448 U.S. 176, 221 (1980) (reviewing a patent on a new use for a known product and noting that "[d]evelopment of new uses for existing chemicals is thus a major component of practical chemical research").

278. U.S. patent law "permits parties to obtain [new] patents on new uses for existing inventions." Abramowicz, *supra* note 43, at 1100.

One example of a chemical compound that may have many alternate uses is a form of synthetic human DNA known as cDNA.[279] Recently, the U.S. Supreme Court upheld the patentability of cDNA in *Association for Molecular Pathology v. Myriad Genetics, Inc*.[280] The defendant in the case, Myriad Genetics, Inc., discovered that mutations of two human genes, labeled BRCA1 and BRCA2, substantially increase the chance of breast and ovarian cancer.[281] Myriad Genetics obtained patents on the genes both as isolated fragments of naturally occurring human DNA and as synthetic cDNA sequences.[282] In reviewing the validity of these patents, the Supreme Court concluded that patent protection was not available for the genes as isolated segments of naturally occurring DNA, but readily affirmed the patentability of the cDNA segments.[283] Importantly, although Myriad obtained patents covering all uses of the cDNA versions of BRCA1 and BRCA2, Myriad disclosed only certain uses for those synthetic genes, such as diagnosing whether a patient faces an increased risk of breast and ovarian cancer by determining if the patient's DNA includes the mutated BRCA1 or BRCA2 genes.[284] As a result, Myriad's patents would cover—but importantly not disclose—any later discovered uses for the synthetic genes, such as treatments for remedying the identified genetic mutations or related cancers.[285] Although Myriad might profit from developing such new uses, productive inefficiencies within Myriad—if unchecked by competition—could slow the progress of the research necessary to discover those treatments. Moreover, Myriad's patents may implicate medical conditions unrelated to breast and ovarian cancer because mutations in one gene may cause many different types of cancer[286] and because genes often

279. *See* Gregory Dolin, *Exclusivity Without Patents: The New Frontier of FDA Regulation for Genetic Materials*, 98 IOWA L. REV. 1399, 1414 (2013) (discussing cDNA generally); *see also* Abramowicz, *supra* note 43, at 1097 (noting that prospect theory might have problematic effects when applied to DNA patents).

280. 133 S. Ct. 2107, 2111 (2013).

281. *Id.* at 2112.

282. *Id.* at 2113; *see also* U.S. Patent No. 5,693,473 (filed June 7, 1995) (assigning a human genetics patent to, *inter alios*, Myriad Genetics); U.S. Patent No. 5,709,999 (filed June 7, 1995) (same); U.S. Patent No. 5,710,001 (filed Jan. 20, 1998) (same); U.S. Patent No. 5,747,282 (filed June 7, 1995) (same); U.S. Patent No. 5,753,441 (filed Jan. 5, 1996) (same); U.S. Patent No. 5,837,492 (filed Apr. 29, 1996) (same); U.S. Patent No. 6,033,857 (filed Mar. 20, 2000) (same).

283. *Ass'n for Molecular Pathology*, 133 S. Ct. at 2119 ("cDNA does not present the same obstacles to patentability as naturally occurring, isolated DNA segments.").

284. *Id.* at 2112–13.

285. Since losing their battle in the Supreme Court, Myriad has returned to asserting its patents against competitors that test for mutations in the BRCA1 and BRCA2 genes. Joe Mullin, *Myriad, Fresh off Supreme Court Loss, Keeps on Suing over Gene Patents*, ARS TECHNICA (July 11, 2013, 8:30 AM), http://arstechnica.com/tech-policy/2013/07/myriad-fresh-off-supreme-court-loss-keeps-on-suing-over-gene-patents/.

286. Ohio State Univ. Div. of Nephrology, *Study Shows That Mutations In One Gene Cause Many Cancers*, OHIO ST. UNIV., http://internalmedicine.osu.edu/nephrology/article.cfm?ID=5511 (last visited Aug. 11, 2014). Indeed, Myriad's patents explicitly state that mutations in the BRCA1

overlap one another.[287] Once again, Myriad might profit from exploring the relationships among BRCA1, BRCA2, and other types of cancer. Without sufficient competition, though, productive inefficiencies could prompt Myriad to focus only on areas of existing expertise, such as breast and ovarian cancer.

One promising approach to limiting the productive inefficiencies from patents on multiuse compounds is to establish a robust experimental-use defense to promote competition regarding the discovery of alternate uses. Today, U.S. patent law usually prevents competitors from experimenting on patented technology. Although there is a general experimental-use defense, current U.S. patent law limits it to experimentation "for amusement, to satisfy idle curiosity, or for strictly philosophical inquiry."[288] For example, an experiment "in furtherance of the alleged infringer's legitimate business" typically does not qualify for the defense.[289] As a result, patent law often limits competition—thereby fostering productive inefficiency—regarding the development of alternative uses for patented compounds. Although the experimental-use defense is narrow in most areas of technology, U.S. patent law contains a stronger statutory experimental-use defense in areas of technology "reasonably related" to the manufacture, use, and sale of drugs.[290] For these technologies, patent law insulates much research regarding alternate uses of drugs from claims of patent infringement, thereby limiting, to some extent, the productive inefficiencies stemming from patents on drug-related compounds.[291] For example, although patents on cDNA could contribute to substantial productive inefficiencies for the reasons noted above, the existing experimental-use defense may mitigate this problem. Nevertheless, the statutory defense for experimentation reasonably related to drugs does not fully address productive-inefficiency concerns because the defense does not apply to basic scientific research regarding patented compounds.[292] Moreover, outside of these areas of technology the experimental-use defense is extremely narrow.

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and BRCA2 genes relate to breast cancer, ovarian cancer, colorectal cancer, and prostate cancer and "may be involved in the initiation and/or progression of other types of tumors." U.S. Patent No. 5,693,473 col. 19 ln. 27–29 (filed June 7, 1995).

287. Natalie Ram, *Assigning Rights and Protecting Interests: Constructing Ethical and Efficient Legal Rights in Human Tissue Research*, 23 HARV. J.L. & TECH. 119, 153 (2009) ("And while biologists have often assumed that genes are compact, the new research indicates that genes can be sprawling, with far-flung protein-coding and regulatory regions that overlap with other genes." (internal quotation marks omitted)).

288. Madey v. Duke Univ., 307 F.3d 1351, 1362 (Fed. Cir. 2002) (internal quotation marks omitted).

289. *Id.*

290. 35 U.S.C. § 271(e)(1) (2012). The Federal Food, Drug, and Cosmetic Act defines "drug" to include any "articles intended for use in the diagnosis, cure, mitigation, treatment, or prevention of disease in man." 21 U.S.C. § 321(g)(1).

291. *See* Merck KGaA v. Integra Lifesciences I, Ltd., 545 U.S. 193, 207 (2005).

292. *Id.* at 205–06.

Therefore, a stronger defense to patent infringement for experimentation related to the development of alternate uses for chemical compounds may help to reduce productive inefficiencies. Such a defense could be tailored to preserve the patentee's incentives to discover and disclose a new compound. For example, to qualify for the experimental use defense, patent law could require a competitor to demonstrate that its research targets a use that is substantially different from any uses for the compound identified in the patent, utilized by the patentee, or found in the prior art. Furthermore, the defense could apply only to experimentation by a competitor and not to the commercial use of the fruits of such experimentation. Accordingly, to commercialize the alternative use a competitor would need to license the patent from the patent owner. To facilitate such licensing, the competitor could seek a patent on the method of using the compound for the newly discovered use.[293] Such an expanded but focused experimental use defense would facilitate the development of alternate uses for patented compounds by reducing productive inefficiencies while maintaining robust incentives to patent and disclose new compounds.

E. *Irrational Ignorance at the Patent Office*

Considerations of productive inefficiency also shed new light on an unresolved debate regarding the examination of patent applications by the U.S. Patent Office. The U.S. Patent Office accepts more than half of a million applications for patents every year.[294] Unfortunately, the examination of these applications is, in the eyes of many observers, an ineffective process.[295] Though the U.S. Patent Office strives to issue only clear, valid patents, mistakes are common, in part because budgetary constraints force patent examiners to spend very little time reviewing each patent application.[296] By one estimate, patent examiners spend on average only eighteen hours reviewing a typical patent application.[297] As a result,

293. Abramowicz, *supra* note 43, at 1100 ("[T]he current [U.S.] patent system permits parties to obtain [new] patents on new uses for existing inventions."); Merges & Nelson, *supra* note 11, at 860.

294. U.S. PATENT & TRADEMARK OFFICE, *supra* note 210.

295. Patent examination is also a slow process. Today, patent applications languish for about eighteen months before receiving an initial review by an examiner, and the entire examination process typically lasts almost thirty months. U.S. PATENT & TRADEMARK OFFICE, DATA VISUALIZATION CENTER, http://www.uspto.gov/dashboards/patents/main.dashxml (last visited Aug. 11, 2014).

296. Doug Lichtman & Mark A. Lemley, *Rethinking Patent Law's Presumption of Validity*, 60 STAN. L. REV. 45, 61 (2007); *see* Michael J. Meurer, *Patent Examination Priorities*, 51 WM. & MARY L. REV. 675, 679 (2009) (arguing that examiners make mistakes given the time constraints they face). A U.S. patent can be invalid for many reasons. *See* 35 U.S.C. §§ 101–03, 112 (2012).

297. John R. Allison & Mark A. Lemley, *The Growing Complexity of the United States Patent System*, 82 B.U. L. REV. 77, 135 (2002).

approximately half of the patents whose validity is tested through litigation are ultimately declared invalid.[298] Moreover, the scopes of patents issued by the U.S. Patent Office are notoriously unclear.[299]

Unfortunately, these shortcomings in patent examination significantly reduce social welfare. For example, an invalid patent can raise costs for consumers and competitors without providing the offsetting benefit of a new invention.[300] Similarly, when the scope of a patent is unclear, it may be difficult to determine if a patent is infringed or invalid.[301] Facing invalid or unclear patents, some firms may license unnecessarily or eschew some socially beneficial commercial activity altogether.[302] Although competitors can challenge invalid and unclear patents in court, the cost of doing so is often high.[303]

Patent scholars generally agree that invalid and unclear patents reduce social welfare, however, there is little consensus regarding the best approaches for improving patent examination. Some scholars assert that the U.S. Patent Office should require inventors to provide more information to the examiners to facilitate the review of their patent applications.[304] Other scholars reject this approach, arguing that increasing the burdens on patent applicants is not cost justified because very few patents warrant such expenditures.[305] For example, by one estimate only 5% of patents produce any revenue.[306] Investing additional resources in the examination of *all* patent applications would not be "rational" since such additional examination efforts could not produce any benefits in the vast majority of cases.[307]

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298. John R. Allison & Mark A. Lemley, *Empirical Evidence on the Validity of Litigated Patents*, 26 AIPLA Q.J. 185, 205 (1998).

299. Surden, *supra* note 54, at 1747.

300. Ghosh & Kesan, *supra* note 14, at 1227 (listing the private and social costs resulting from invalid patents); *see also supra* Section II.B.

301. *See* Surden, *supra* note 54, at 1752–55 (discussing costs stemming from patents with unclear scope).

302. Ghosh & Kesan, *supra* note 14, at 1227; Surden, *supra* note 54, at 1752–55.

303. *See* Ghosh & Kesan, *supra* note 14, at 1229 (noting high litigation costs as a subset of high transaction costs).

304. *See, e.g.*, Joseph Scott Miller, *Enhancing Patent Disclosure for Faithful Claim Construction*, 9 LEWIS & CLARK L. REV. 177, 203–05 (2005) (proposing that because inventors can easily provide supplemental information at a very small added cost, inventors should include a glossary of terms in their patent applications); Surden, *supra* note 54, at 1809–10. At the urging of the Obama Administration, the U.S. Patent Office has recently begun exploring the use of glossaries to increase patent clarity. *See Glossary Initiative*, U.S. PATENT & TRADEMARK OFFICE, http://www.uspto.gov/patents/init_events/glossary_initiative.jsp (last visited Aug. 11, 2014).

305. *See* Lemley, *supra* note 58, at 1507.

306. *Id.*; *see also* BESSEN & MEURER, *supra* note 3, at 100 ("[T]he majority of patents are not worth more than a few thousand dollars.").

307. *See* Hubbard, *supra* note 267, at 359–60; Lemley, *supra* note 60, at 1497; Miller, *supra* note 304, at 196.

The debate regarding the efficacy of the U.S. Patent Office is framed only in terms of neoclassical economics. Some scholars contend that the traditional benefits of investing additional resources in patent examination exceed the traditional costs, while other scholars dispute this calculation. All of these scholars, however, implicitly assume that additional investments are the only mechanism for increasing the productivity of "rational" patent examiners.[308] Productive inefficiency analysis rejects this assumption and recognizes that market conditions can affect the productivity of individuals and organizations. In fact, it is highly likely that the Patent Office suffers from substantial productive inefficiencies because it faces virtually no competition. The U.S. Patent Office is the only entity that can issue patents that provide exclusive rights to make, use, or sell an invention throughout the United States, which is the largest market in the world.[309] With this monopoly, the U.S. Patent Office evades the disciplining effects of competition.[310]

Productive inefficiency analysis thus suggests potential mechanisms for improving processes at the Patent Office. In the absence of competition, the Patent Office should use managerial oversight to increase the productive efficiency of patent examiners. Admittedly, this has been the traditional approach to improving examiner output at the Patent Office, and as described above, management faces many challenges in doing so. For example, it is difficult for management to know how many patent applications a focused and diligent examiner could process in a given time period.[311]

Recent changes to U.S. patent law may help to fill this information void. Specifically, in 2010, the U.S. Patent Office opened a satellite branch in Detroit, Michigan.[312] Similarly, in passing the Leahy–Smith America Invents Act in the fall of 2011, Congress required the Patent Office to "establish 3 or more satellite offices in the United States to carry out the responsibilities of the Office."[313] Pursuant to this mandate, the Patent Office announced in July 2012 plans to open regional U.S. Patent and Trademark Offices near Dallas, Denver, and Silicon Valley.[314]

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308. *See* Ghosh & Kesan, *supra* note 14, at 1248–50 (critiquing other scholars for failing to recognize the effects of bounded rationality on the U.S. Patent and Trademark Office).

309. Hubbard, *supra* note 13, at 1935–38 (characterizing the United States as "the largest consumer market in the world").

310. *See* FRANTZ, *supra* note 17, at 136.

311. *See supra* notes 149–54 and accompanying text.

312. *U.S. Patent and Trademark Office Opens First-Ever Satellite Office in Detroit, Michigan*, U.S. PATENT & TRADEMARK OFFICE (July 13, 2012), http://www.uspto.gov/news/pr/2012/12-41.jsp.

313. Leahy-Smith America Invents Act, Pub. L. No. 112-29, § 23, 125 Stat. 284, 336–37 (2011).

314. *U.S. Commerce Department to Open Four Regional U.S. Patent Offices That Will Speed Up the Patent Process and Help American Businesses Innovate, Grow, and Create Jobs*, U.S. PATENT & TRADEMARK OFFICE (July 2, 2012), http://www.uspto.gov/news/pr/2012/12-40.jsp.

Although the details of these offices are still coalescing, the Patent Office and Congress could create conditions that emulate competition among the offices in at least three respects.[315] First, allowing each office to hire its own examiners would allow the offices to compete with each other for talented personnel. Second, Congress could tie the funding for each office to the office's performance in some respects. For example, if inventors are able to choose freely which office will review their applications, Congress could use the number of applications to an office to determine funding for each office. If the Dallas office were to reduce examination delays or develop a reputation for issuing patents that were less likely to be invalid, more inventors might file applications with that office, thereby increasing the funding for the Dallas office. Some of that largess might be passed on to the examiners either in the form of higher salaries or perks, thereby encouraging the examiners to increase their productivity. Because inventors might gravitate towards an office that applies lower standards of patentability, Congress might also reduce funding based on the frequency of patents from each office being held invalid in litigation. Third, if the U.S. Patent Office were to collect and disseminate information regarding the productivity of each office, comparisons between the different offices may help managers in some offices to reduce examiner productive inefficiencies. For instance, if examiners in the Dallas office work more expeditiously than examiners in the Detroit office, managers in the Detroit office might apply greater pressure on their examiners to improve their productivity. Similarly, one office could learn of successful work flow mechanisms by hiring examiners away from a "competitor" satellite office.

CONCLUSION

The effects of patent law on society are undoubtedly complex. Patents can benefit society by stimulating socially beneficial invention. Nevertheless, patents also limit competition and thus can deny society the benefits that robust competition produces. In seeking to understand this trade-off, lawmakers and scholars have relied upon traditional—but simplified—economics, including the foundational assumption that firms always maximize their profits.

Modern economic scholarship acknowledges that, in reality, individuals and firms often do not maximize their profits due to productive inefficiencies. For instance, cognitive biases, bounded rationality, and bad habits cause individuals to fail to maximize their own welfare. Moreover, employees often opportunistically pursue personal objectives that undermine firm profits. Rather than assiduously working to maximize firm

315. *See* Posner, *supra* note 5, at 574 (noting that even multiple local monopolies in different regions can provide "sufficient diversity to produce many useful examples for emulation by the others").

profits, employees may seek on-the-job leisure, personal relationships, perquisites, and status. When patents or other forces restrict competition, productive inefficiencies can take root.

Unfortunately, legal scholars and policy makers have overlooked productive inefficiencies and have ignored a substantial cost associated with patent protection. The critique that economist A.T. Hadley made of economics more than a century ago applies with equal force to patent scholarship today: "We have been so accustomed to think of competition as a regulator of prices that we have lost sight of its equally important function as a stimulus to efficiency."[316] To better calibrate patent law for social benefit, lawmakers should consider all of the costs and benefits stemming from patent protection, including both those described by traditional economics as well as the costs from productive inefficiencies. Indeed, the more fulsome approach to patent analysis described in this Article sheds light on unresolved and long-running debates regarding the commercialization of patented inventions, the optimal scope of patents on chemical compounds, and the improvement of patent examination.

316. Hadley, *supra* note 134, at 383.