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PATENT PORTFOLIOS

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This article develops a comprehensive theory of patent value, responding to growing empirical evidence that the traditional appropriability premise of patents is fundamentally incomplete in the modern innovation environment. We find that for patents, the whole is greater than the sum of its parts: the true value of patents lies not in their individual worth, but in their aggregation into a collection of related patents—a patent portfolio.

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The patent portfolio theory thus explains what is known as "the patent paradox": in recent years patent intensity—patents obtained per research and development dollar—has risen dramatically even as the expected value of individual patents has diminished. We find the benefits of patent portfolios to be so significant as to suggest that firms' patenting decisions are largely unrelated to the expected value of individual patents; because patent portfolios simultaneously increase both the scale and the diversity of available marketplace protections for innovations, firms will typically seek to obtain a large quantity of related patents, rather than evaluating their actual worth. The result—which we find widely recognized in commercial circles—is that the modern patenting environment exhibits (and requires) a high-volume, portfolio-based approach that is at odds with scholars' traditional assumptions.

The implications of the portfolio theory of patents are important and widespread. First, the explanatory power of the theory allows resolution not only of the patent paradox, but also of many of the otherwise puzzling observable patterns in the modern patenting environment, such as firm-size differences in patent intensity and litigation rates. Second, the patent portfolio theory neatly complements the prior theories that have sought to explain modern patent value, strengthening their relationship with the reality of patenting behavior, and confirming that the value of patents has expanded beyond traditionalist notions. Third, the patent portfolio theory offers a number of important predictive insights into future trends in the patent system, allowing policymakers and scholars to frame their inquiry within a range of likely outcomes. In our analysis, the patent portfolio theory does not suggest a better, brighter future for the patent system, but does build a foundation for the important academic and policy-related work that springs from this initial treatment.

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INTRODUCTION

What is the value of patents? This deceptively simple question has occupied a generation of patent scholars and policy-makers, because the modern patent system presents a seemingly insoluble puzzle.[1] On

[1] A few notable examples of the scholarly inquiry into patent value include PATENTS IN THE KNOWLEDGE-BASED ECONOMY (Wesley M. Cohen & Stephen A. Merrill eds., 2003) (analyzing the effects of the patent examination process on patent quality, durability, and the patent marketplace); KEVIN G. RIVETTE & DAVID KLINE, REMBRANDTS IN THE ATTIC: UNLOCKING THE HIDDEN VALUE OF PATENTS (2000) (offering advice about how to wield patents and compete in the intellectual property arena); Bronwyn H. Hall & Rosemarie Ham Ziedonis, *The Patent Paradox Revisited: An Empirical Study of Patenting in the U.S. Semiconductor Industry, 1979-1995*, 32 RAND J. ECON. 101, 125 (2001) (examining the multifaceted effects on semiconductor firms of strengthening patent rights); Adam B. Jaffe, *The U.S. Patent System in Transition: Policy Innovation and the Innovation Process*, 29 RES. POL'Y 531 (2000) (reviewing the changes in patent policy during the past two decades and the theoretical literature related to the expected effects of such changes); Samuel Kortum & Josh Lerner, *What Is Behind the Recent Surge in Patenting?*, 28 RES. POL'Y 1 (1999) (explaining the large increase in patenting during the 1990s); Richard C. Levin et al., *Appropriating the Returns from Industrial Research and Development*, 3 BROOKINGS PAPERS ON ECON. ACTIVITY 783 (1987) (inquiring into the nature of appropriability conditions in over one hundred manufacturing industries); Clarisa Long, *Patent Signals*, 69 U. CHI. L. REV. 625 (2002) (focusing on patents as a means for credibly publicizing information); Edwin Mansfield, *Patents and Innovation: An Empirical Study*, 32 MGMT. SCI. 173 (1986) (investigating the effects of the patent system by firms on the rate of development and commercialization of inventions); Robert P. Merges & Richard R. Nelson, *On the Complex Economics of Patent Scope*, 90 COLUM. L. REV. 839 (1990) (analyzing the economic effects of patent scope); Ariel Pakes, *On Patents, R & D, and the Stock Market Rate of Return*, 93 J. POL. ECON. 390 (1985) (investigating the relationship between the number of patent applications, R&D expenditures, and the stock market value of firms); Mark Schankerman, *How Valuable Is Patent Protection? Estimates by Technology Field*, 29 RAND J. ECON. 77 (1998) (presenting evidence on the value of patent rights in France); F.M. Scherer, *The Innovation Lottery*, *in* EXPANDING THE BOUNDARIES OF INTELLECTUAL PROPERTY: INNOVATION POLICY FOR THE KNOWLEDGE SOCIETY 3 (Rochelle Cooper Dreyfuss et al. eds., 2001) (showing wide disparities in the relative growth of investments in technology companies); Wesley M. Cohen, *Protecting Their Intellectual Assets: Appropriability Conditions and Why U.S. Manufacturing Firms Patent (or Not)* 3 (Nat'l Bureau of Econ. Research, Working Paper No. 7552, 2000), http://www.nber.org/papers/w7552 (indicating that firms often patent for reasons beyond profiting from a patented innovation).

Very current examples of this general inquiry include: Mark A. Lemley & Carl Shapiro, *Probabilistic Patents* (Stanford Law School, Olin Working Paper No. 288, 2004), http://ssrn.com/abstract=567883 (discussing the implications of the low and uncer-

the one hand, the amount of patenting activity has dramatically increased in recent years.[2] On the other hand, all available evidence demonstrates that the average expected value of a patent is extremely small (and likely negative when acquisition costs are considered): the overwhelming majority of patents have no value whatsoever, and of those that have value, it is nearly impossible to determine ex ante.[3] These enduring and simultaneous facts fundamentally challenge the conventional understanding of the patent system as a generator of incentives to invent: if patents on inventions have little or no expected economic value, why do individuals and commercial corporations patent so heavily?[4] Or, if patents are valuable after all, where does their value lie? We refer to this puzzle (as do others) as *the patent paradox*.[5]

In this Article, we develop a comprehensive theory of patent value: the portfolio theory of patents. The portfolio theory both puts to rest the patent paradox and explains the salient characteristics of the modern patent system. At the core of the portfolio theory lies the insight that for patents, *the whole is greater than the sum of its parts*. The true value of patents inheres not in their individual worth, but in their

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tain value of individual patents); Kimberly A. Moore, *Worthless Patents* (George Mason Univ. School of Law, Working Paper No. 04-29, 2004), http://ssrn.com/abstract=566941 (noting the low value of most individual patents and exploring common attributes among abandoned patents).

[2] See *infra* Part I.A for a full discussion of the growth in patenting activity. As a general matter, patent filings rose about 40% during the period 1998-2003. *See infra* Table 1. Patent intensity—the measure of patents obtained per research and development dollar—approximately doubled from the mid 1980s to the late 1990s. *See, e.g.*, A PATENT SYSTEM FOR THE 21ST CENTURY 30 (Stephen A. Merrill, Richard C. Levin & Mark B. Myers eds., 2004) (explaining the rapid increase in patents per research and development dollar over this fifteen-year period).

[3] See *infra* Part I.A for a full discussion of the low average expected value of patents; see also *infra* Table 2 for data on this point. In broad strokes, we note that empirical studies find the average value of a patent to be in the range of about $7,500 to $25,000, which is generally less than average acquisition costs. *See, e.g.*, Schankerman, *supra* note 1, at 93-94. Furthermore, most estimates suggest that less than 5% of patents have any apparent value at all—less than 1% are litigated (and these are found invalid at a rate of about 50%)—and only a small additional number are licensed. *See* Mark A. Lemley, *Rational Ignorance at the Patent Office*, 95 NW. U. L. REV. 1495, 1507 (2001) ("[A] relatively small percentage of the 150,000 or so patents issued each year are actually licensed to third parties in exchange for royalties.").

[4] While the number of patents issued to individuals has risen significantly, the substantial growth during the last fifteen years is overwhelmingly due to the number of patents issued to corporations; the number issued to the United States government has remained relatively constant. *See generally* U.S. PATENT AND TRADEMARK OFFICE, PERFORMANCE AND ACCOUNTABILITY REPORTS (1991-2003).

[5] *See, e.g.*, Hall & Ziedonis, *supra* note 1, at 125 (examining the patenting behavior of semiconductor firms). See generally *infra* Part I for empirical documentation of the patent paradox.

aggregation into a collection of related patents—a patent portfolio.[6] The benefits of patent portfolios are of such significance, we show, that firms' patenting decisions are largely unrelated to the expected value of individual patents.[7] Rational firms will therefore typically seek to obtain a large quantity of related patents, rather than evaluating their individual worth.[8] The result is that the modern innovation environment exhibits (and requires) a high-volume, portfolio-based approach to the patent system that is at odds with conventional scholarly assumptions.

It is important to note at the outset that we are not the first to identify the existence of patent portfolios, nor are we the first to coin this term. These are not the contributions we claim. Rather, the contribution of this Article is in the molding of the sporadic and disperse discussions of the phenomenon of patent portfolios into a consistent and full-blown theory of patent value, which we then use to explain the modern patent system and predict future trends.

Our patent portfolio theory thus extends well beyond recent efforts by academics to address the patent paradox by positing alternative views of patent value.[9] These approaches either suffer from assumptions that individual patents efficiently convey meaningful information (when in fact the evidence of vanishingly low patent values undermines this premise), or posit a generalized alternative utility for patents that does not fully fit the actual facts of the modern patent system.[10] For example, we note that while suggestions that patents act as "signals" of qualities about the invention or the firm or as useful metrics of internal firm measurement and management have intuitive

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[6] *See infra* Part II.

[7] *See id.*

[8] *See infra* Part II.C.

[9] We note four major alternative theories: (1) the signaling theory, which posits that patents cheaply provide valuable information about the invention or the firm; *see, e.g.*, Long, *supra* note 1, at 625 (presenting a model of patents as a signaling mechanism); (2) the internal metric theory, which suggests that individual patents are useful tools for the measurement of performance within firms; *see, e.g.*, Richard C. Levin, *A New Look at the Patent System*, 76 AM. ECON. REV., May 1986, at 199, 201 (proposing that patents may be used to measure the performance of research and development employees); (3) the lottery theory, which analogizes a patent to a lottery ticket, with a very small chance of a very large payoff; *see, e.g.*, Scherer, *supra* note 1, at 11 (demonstrating that among patent recipients, a "minority of 'spectacular winners' appropriate the lion's share of total rewards"); and (4) the defensive patenting theory, where patents are obtained to counter other patents; *see, e.g.*, Lemley, *supra* note 3, at 1504 ("[T]here is anecdotal evidence that at least among high-technology and startup companies, the primary purpose of patents is defensive."). We discuss the shortcomings of these theories in detail in Part I.B.

[10] *See infra* Part I.B.

appeal, they prompt serious questions about what, exactly, is the information conveyed by individual patents.[11] Put another way, if (as all available studies confirm) most individual patents have little or no value, then why is information about individual patents valuable? More generally, why would the market—or anyone else for that matter—care about information pertaining to a relatively valueless commodity?[12]

As we will show, the patent paradox disappears once patents are analyzed at the portfolio level.[13] The holder of a patent portfolio realizes an array of strategic advantages—offensive and defensive—that are simply not otherwise available.[14] We establish a two-category framework for understanding these benefits. First, by combining the "right to exclude" of many closely related patents, a patent portfolio greatly increases the effective *scale*—the total scope of protection in the marketplace—beyond that of a collection of differentiated patents.[15] That is, a well-conceived patent portfolio operates much like a "super-patent"; its scale-effects mean that a holder wields otherwise-unattainable market power in a particular technological field. This marketplace heft has a number of crucial impacts, including (1) easing subsequent innovation by broadening the scope of effective patent protection; (2) attracting related external innovations by virtue of the enhanced power to exclude others from the marketplace; (3) avoiding costly litigation by greatly increasing the likelihood that alleged

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[11] *See id.*

[12] In addition, we reject the possibility that the patent paradox is merely an example of bounded rationality. *See, e.g.*, Russell Korobkin, *Bounded Rationality, Standard Form Contracts, and Unconscionability*, 70 U. CHI. L. REV. 1203 (2003) (arguing that nondrafting parties to contracts are boundedly rational decision makers, and only take into account a limited number of product attributes as part of their purchase decision); Avishalom Tor, *The Fable of Entry: Bounded Rationality, Market Discipline, and Legal Policy*, 101 MICH. L. REV. 482, 561-63 (2002) (highlighting the ways in which competitive forces facilitate bounded rationality in the marketplace). The major drivers of the recent increases in patenting activity are medium-to-large corporations, whose operations are marked by careful and highly sophisticated decision making. Furthermore, they operate in a competitive environment that is quite unforgiving of long-term irrational behavior. For example, IBM, Intel, and Hewlett-Packard are among the Dow 30 component companies that have consistently ranked among the top patent recipients in recent years. *See, e.g.*, Press Release, U.S. Patent and Trademark Office, USPTO Releases Annual List of Top 10 Organizations Receiving Most U.S. Patents (Jan. 12, 2004), http://www.uspto.gov/web/offices/com/speeches/04-01.htm (ranking IBM, Intel, and Hewlett-Packard as numbers one, seven, and five, respectively, for number of patents received in 2003). For further discussion, see *infra* Part I.A.

[13] *See infra* Part II.

[14] *See infra* Part II.B.

[15] *See infra* Part II.B.1.

infringers and (even more importantly) putative plaintiffs in infringement actions will be forced off the market; (4) improving the holder's bargaining positions with competitors and third-parties alike; (5) enhancing the defensive aspects of patent protection by providing a far more credible threat of counter-infringement litigation; and (6) increasing the holder's voice in the dynamic political economy of the patent system.[16]

Second, while the scale-effects of patent portfolios alone are of immense importance to firms in the modern economy, patent portfolios offer yet another and no less important advantage: *diversity*.[17] That is, while patent portfolios may at times function as "super-patents," they are nonetheless constructed from an array of distinct-but-related individual patents, thus offering holders many of the well-known benefits of asset diversification in addition to market power.[18] The diversity-effects of patent portfolios mean that, among other benefits, holders can (1) effectively address future uncertainties related to technological development, market conditions, and competitor moves by offering a much broader array of protected subject matter; (2) expand the scope of the research and development inquiry into areas adjacent to the main path of research, thus maximizing technological opportunity; and (3) increase the long-term predictability of and confidence in holders' exclusionary rights by minimizing the consequences of many of the current uncertainties inherent in the patent law itself.[19]

We demonstrate that the advantages of patent portfolios are well-recognized in commercial circles, cutting across both technological fields and firm sizes.[20] While large firms provide perhaps the most compelling example of patent portfolios in practice—for example, since the mid-1990s, IBM has avowedly followed a portfolio-focused patenting strategy, which yielded a more than 400% increase in patent-related revenues (to about $1.5 billion, or about a quarter of total corporate receipts) even as the research and development budget was slashed[21]—we also find real world case studies of patenting behavior consistent with our theory among startups and acquisition-centric firms.[22] Indeed, the rise of patent portfolios in the business commu-

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[16] *See id.*

[17] *See infra* Part II.B.2.

[18] *See id.*

[19] *See id.*

[20] *See infra* notes 107-26 and sources cited therein.

[21] *See infra* Part III.B (IBM case study).

[22] *See infra* Part III.A (Qualcomm case study); Part III.C (Gemstar case study).

nity has become so significant that portfolios have become the credo of firm value in the modern innovation environment.[23]

The implications of the patent portfolio theory for scholars and policymakers are quite significant. First and foremost, this Article stakes out a new path for future research concerning the patent system. In particular, it suggests that scholars should go beyond the strict focus on individual patents and devote greater attention to patent portfolios and their implications. At a minimum, the introduction of the portfolio theory requires a careful reevaluation of the incentive effects of patents, patenting strategies, and patent valuation techniques. For example, we show, contrary to conventional wisdom, that firms do not necessarily base their patenting decisions on cost-benefit analyses of individual patents. Rather, firms will continue to obtain patents as long as the marginal increase in value of the portfolio from an additional patent is greater than the acquisition cost of that patent; estimates of an individual patent's value independent of a portfolio often do not enter the equation.[24]

Furthermore, the patent portfolio theory provides a unifying framework that can neatly incorporate prior scholarly contributions.[25] For example, patents do appear to have signaling effects at the portfolio level, even though their significance is slightly different from what extant analysis suggests.[26] Additionally, the portfolio theory recognizes that some individual patents may be of great independent value to their inventors. It suggests, however, that inventors can increase the value of such patents by constructing a portfolio around them. Finally, the oft-discussed defensive theories of patent value are greatly enhanced by understanding them in the context of substantial patent portfolios.[27]

The patent portfolio theory also enables a number of important predictions about the future course of the patent system.[28] We predict that patent intensity (patents obtained per R&D dollar) will continue to be high, that the Patent and Trademark Office (PTO) will face increasing pressure as a result, that patent "thickets" will proliferate and

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[23] *See infra* Part II.

[24] Indeed, if there is any relationship between individual value and patent activity, we note that it will be inverse: as the average expected value of individual patents drops, patenting activity will increase, as firms are increasingly forced to rely on portfolio-based strategies to achieve any patent-related advantages. *See infra* Part II.C.

[25] *See infra* Part IV.B.

[26] *See id.*

[27] *See id.*

[28] *See infra* Part IV.C.

become a growing policy concern, and that patent litigation will become more complex and costly.[29] We also conclude that the portfolio-dominated patent system will have serious distributional consequences, where large, resource-rich, incumbent firms will see a mounting advantage because of their ability to more effectively implement a patenting strategy based on patent portfolios.[30] Companies with small patent portfolios will find it difficult to compete against firms with large patent holdings. This, however, does not mean that small innovators will disappear from the market; rather, we will witness increasing segmentation of the innovation market, with startups and small firms complementing, or filling "gaps" in, the portfolios of larger companies.

As for the normative implications, the patent portfolio theory foretells a more complex, costly, and distributionally significant patent system.[31] While the growth of patent portfolios suggests that the patent system will become an increasing source of technological disclosure, and that firms will have potentially beneficial incentives to broaden their research efforts (so as to allow portfolio construction), the net effects are almost certainly negative from a social perspective.[32] Thus, we discuss a number of policy responses that address the challenges arising from a portfolio-driven patent environment. We begin by proposing several mechanisms for shifting the costs (information and otherwise) of patents from the public to potential patent-holders in order to improve the available information about patented inventions and increase the cost of obtaining "low-value" patents.[33] For example, we recommend a reinvigorated doctrine of prosecution history estoppel to force patentees to disclose more information earlier. Adopting this measure would both improve the quality of information about patented inventions and raise the cost of obtaining low-quality patents.[34]

Furthermore, we examine the possibility of introducing a system of differential fees that would correlate the fee charged to patent applicants to the number of patents they hold. This measure would make it more expensive for holders of large portfolios to obtain addi-

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[29] *See id.*

[30] *See id.*

[31] *See id.*

[32] *See id.*

[33] *See infra* Part V.

[34] *See* R. Polk Wagner, *Reconsidering Estoppel: Patent Administration and the Failure of* Festo, 151 U. PA. L. REV. 159, 210-28 (2002) (developing a new theory of prosecution history estoppel that takes into account the way the rule generates ex ante incentives).

tional patents and thus likely reduce the motivation of firms to seek protection for relatively insignificant patents. As for the legislature, we consider whether the relaxation of antitrust-related limitations on mass-licensing of patents will diminish the effects of portfolios by reducing their transaction costs.[35] We also revisit the patent-antitrust interface and argue that the traditional focus on the anticompetitive effects of individual patents must be broadened to take account of the possible harmful effects of the portfolio as a whole. An antitrust policy that is sensitive to portfolio effects will do a better job of curbing anticompetitive practices by dominant patent holders.

At the end of the day, though, it is important to understand the inherent limits of legal intervention in this case. While we propose that targeted legal intervention along these lines will combat egregious cases of patent abuses, it will neither arrest the tendency of firms to patent, nor will it level the innovation playing field. Legal intervention cannot completely negate the private advantages offered by large portfolios. As a consequence, market forces will continue to play a significant role in shaping the future of innovation. Ultimately, the best way for small companies to compete and thrive in this environment will be to exploit technological niches that were ignored by large incumbent firms.[36]

The remainder of the Article is divided into five parts. Part I presents the growing empirical evidence of the patent paradox—the dissonance between traditional theories of patent value and the realities of patent behavior—and critically analyzes the extant scholarly efforts to reconcile the gap between theory and reality.

Part II sets forth the patent portfolio theory, beginning with an introduction to the conceptual framework, and then moving to a detailed discussion of the dual benefits of patent portfolios—scale and diversity—and their widespread commercial recognition. It also analyzes the strategic considerations that firms face in portfolio construction, especially the inherent tension between scale and diversity, and notes why in most cases a high-volume, low-quality approach to patent acquisition will be the dominant choice.

Part III offers real-world case studies of patent portfolios in the modern innovation environment, demonstrating the fit between our theory and commercial reality. Our cases studies show (1) large-firm

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[35] *See infra* Part V.

[36] *See generally* CLAYTON M. CHRISTENSEN, THE INNOVATOR'S DILEMMA: WHEN NEW TECHNOLOGIES CAUSE GREAT FIRMS TO FAIL (1997) (showing how new technologies erupt in the low end of the market and eventually displace reigning technologies).

strategic portfolio construction (IBM), (2) complete domination of a technology by a firm dedicated to patent portfolio construction (Qualcomm), and (3) a small-firm strategy of both in-house and acquisition-based portfolio development (Gemstar).

Part IV discusses the explanatory, predictive, and normative implications of the portfolio theory as well as the complementary relationship between the patent portfolio theory and prior scholarly efforts.

Part V extends the implications discussed in Part IV to develop a range of policy options that address the challenges to the patent system posed by the rise of patent portfolios. While not all of these options will be either easily implemented or politically feasible, we believe that the theory outlined in this article—at the least—requires a broadening of the conversation.

I. THE PERSISTENCE OF THE PATENT PARADOX

In this part, we set out to accomplish two tasks. First, we introduce the patent paradox. Second, we present and critically evaluate the major theories that have been proffered in the literature to address the patent paradox. We find that each of these approaches, while offering some potential insight, falls short of a complete explanation of the true value of patents in the modern innovation environment.

A. *The Patent Paradox: A Primer*

The standard justification for the existence of patent protection is that patents are necessary to solve an appropriability problem that would otherwise plague the production of innovative products and processes.[37] The appropriability problem stems from the "public good" characteristics of intellectual goods.[38] Unlike tangible goods,

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[37] *See, e.g.*, Kenneth W. Dam, *The Economic Underpinnings of Patent Law*, 23 J. LEGAL STUD. 247, 247 (1994) (discussing the "appropriability problem" that arises when firms cannot recoup R&D expenses).

[38] *See, e.g.*, Wendy J. Gordon, *Fair Use as Market Failure: A Structural and Economic Analysis of the* Betamax *Case and Its Predecessors,* 82 COLUM. L. REV. 1600, 1610-11 (1982) (arguing that intellectual property law attempts to prevent free riders from using public goods); William M. Landes & Richard A. Posner, *An Economic Analysis of Copyright Law,* 18 J. LEGAL STUD. 325, 326 (1989) (highlighting that "a distinguishing characteristic of intellectual property is its 'public good' aspect"); *see also* Richard P. Adelstein & Steven I. Perez, *The Competition of Technologies in Markets for Ideas: Copyright and Fair Use in Evolutionary Perspective*, 5 INT'L REV. L. & ECON. 209, 218 (1985) (comparing public goods to intellectual goods). For a view that intellectual works do not share the distinguishing attributes of public goods, see Tom G. Palmer, *Intellectual Property: A Non-*

public goods share two distinctive characteristics: non-rivalry of consumption and non-excludability of benefits.[39] A good is non-rival in consumption "when a unit of [that] good can be consumed by one individual without detracting, in the slightest, the consumption opportunities still available to others from that same unit."[40] A good displays non-excludable benefits when individuals who have not paid for the production of that good cannot be prevented (at a reasonable cost)[41] from availing themselves of its benefits.[42] The non-excludability property of public goods gives rise to two related problems. First, public goods are likely to be underproduced if left to the private market. Second, markets for public goods will not form.

Since inventions are essentially information goods, they too are susceptible to the twin problems of under-production and lack of market exchange.[43] Absent patent protection, copiers would be able to appropriate much of the value embodied in inventions without in-

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Posnerian Law and Economics Approach, 12 HAMLINE L. REV. 261, 273-87 (1989) (criticizing the application of a Posnerian theory of property rights to intellectual property).

[39] *See, e.g.*, ROBERT COOTER & THOMAS ULEN, LAW AND ECONOMICS 46-47 (4th ed. 2004) (explaining the two distinctive characteristics of public goods); RICHARD CORNES & TODD SANDLER, THE THEORY OF EXTERNALITIES, PUBLIC GOODS, AND CLUB GOODS 6-7 (1986) (providing concrete examples of non-rivalry and indivisibility); EDWIN MANSFIELD, PRINCIPLES OF MACROECONOMICS 400-04 (6th ed. 1989) (discussing the political nature of public goods and noting that national defense is an example of one).

[40] CORNES & SANDLER, *supra* note 39, at 6 (emphases omitted).

[41] It should be noted that the impossibility of exclusion is rarely absolute. For example, when examining exclusion by contract, very few goods, if any, display non-excludable benefits in the strict sense of the term. Thus, it is more accurate to describe goods as displaying non-excludable benefits when it is prohibitively expensive to bar non-payers from enjoying the good. *See* Patrick Croskery, *Institutional Utilitarianism and Intellectual Property*, 68 CHI.-KENT L. REV. 631, 632 (1993) (broadly defining non-exclusivity to include "goods which can only be used exclusively at great expense").

[42] CORNES & SANDLER, *supra* note 39, at 6 (listing examples of non-excludable goods to demonstrate that they are available to everyone regardless of who paid for them).

[43] *See generally*, Dam, *supra* note 37 (analyzing the secondary economic problems created by the patent system); John S. McGee, *Patent Exploitation: Some Economic and Legal Problems*, 9 J. L. & ECON. 135 (1966) (discussing the extent to which the property rights bestowed by patents are limited by the monopoly power that accompanies them); Dan Usher, *The Welfare Economics of Invention*, 31 ECONOMICA 279 (1964) (demonstrating how the patent system causes the behavior of a competitive system to deviate from a Pareto optimum); Richard R. Nelson, *The Economics of Invention: A Survey of the Literature*, 32 J. BUS. 101 (1959) (reviewing the literature on the economics of invention); STAFF OF THE S. SUBCOMM. ON PATENTS, TRADEMARKS, AND COPYRIGHTS OF THE S. COMM. ON THE JUDICIARY, 85TH CONG., AN ECONOMIC REVIEW OF THE PATENT SYSTEM (Comm. Print 1958) (prepared by Fritz Machlup) (analyzing unresolved economic inconsistencies in the patent system).

curring the considerable costs of research and development.[44] In such a world, however, inventors would likely put their creative skills to rest and too few inventions would be produced. Patents remedy the appropriability problem that attends the production of information goods by bestowing upon inventors exclusive rights in the inventions they divined.[45]

The appropriability story has undeniable elegance and commonsense appeal, but it appears to suffer from one major problem: it does not seem to be borne out by reality. For the appropriability story to hold, patents must be shown to be an effective means of capturing value. In other words, patent protection must be valuable for inventors. Yet extant empirical research consistently demonstrates that industry participants do not consider patents an effective appropriation mechanism; on the contrary, they deem patents inferior to other methods, such as lead time, learning curve advantages, and even secrecy.[46] More importantly, other empirical studies suggest that the average value of an issued patent is actually quite small. The vast majority of U.S. patents pass their lives in complete idleness, gathering dust rather than revenues.[47] According to Mark Lemley, "the total number of patents litigated or licensed for a royalty (as opposed to a cross-license) is on the order of *five percent* of issued patents."[48] Worse yet, data about renewal rates reveal that nearly half of U.S. patents do not even reach the ten-year mark, and two-thirds lapse before the full twenty-year statutory protection term, as inventors prefer to abandon their patents and forego the payment of a modest renewal fee.[49] The

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[44] *See, e.g.*, Jonathan M. Barnett, *Cultivating the Genetic Commons: Imperfect Patent Protection and the Network Model of Innovation*, 37 SAN DIEGO L. REV. 987, 991 (2000) ("The incentive theory correctly states that patent protection stimulates private investment by warding off low-cost imitators and promising monopolistic profits that will at least cover product development costs.").

[45] Or, as Judge Richard Posner succinctly explained the rationale underlying the patent system, "the manufacturer . . . will not sow if he won't be able to reap." RICHARD A. POSNER, ECONOMIC ANALYSIS OF LAW § 3.3, at 43 (5th ed. 1998).

[46] *See* Cohen et al., *supra* note 1, at 3 (finding that secrecy is heavily employed to protect product innovations); Levin et al., *supra* note 1, at 793-802 (illustrating the various methods of protecting competitive advantages).

[47] *See* Richard J. Gilbert, *Patents, Sleeping Patents, and Entry Deterrence*, *in* STRATEGY, PREDATION, AND ANTITRUST ANALYSIS 205 (Steven C. Salop ed., 1981) (discussing the advantages and legality of the accumulation of patents).

[48] Lemley, *supra* note 3, at 1507 (emphasis added).

[49] *See* Francesca Cornelli & Mark A. Schankerman, *Patent Renewals and R&D Incentives*, 30 RAND J. ECON. 197, 197 (1999) (arguing that a menu of patent lives and fees is a more optimal mechanism than a uniform patent system). Data from other countries is consistent with these findings. For example, in a study that covered over a million French patents applied for between 1951 and 1979 and about half a million Ger-

patent renewal data thus suggest that many patents have no commercial value at all.

Table 1: Percentage of Patents Renewed at Each Stage[50]

	1994*	1995**	1996*	1997	1998	1999	2000	2001	2002	2003
First Stage (3.5 years)	76%	80%	79%	80.3%	81.8%	83.1%	84.3%	84.5%	85.1%	86.8%
Second Stage (7.5 years)	54%	57%	55%	55.8%	56.6%	57.9%	59.4%	59.9%	59.5%	61.1%
Third Stage (11.5 years)	34%	25%	32%	35.4%	36.1%	37.7%	38.8%	39.1%	38.4%	42.9%

Nevertheless, the renewal data cannot be used to calculate the *average* value of patents.[51] To arrive at an accurate estimation of this figure, it is necessary to know the cost of patent protection, as well as the average expected value of patents. Data about the costs associated with patent protection are readily available. The cost of filing a patent application with the PTO, including attorney, filing, issue and renewal fees, is between $10,000 and $30,000.[52] For inventions requiring in-

man patents issued between 1952 and 1972, Ariel Pakes found that only 7% of the French patents and 11% of the German patents were kept until their expiration date. Ariel Pakes, *Patents as Options: Some Estimates of the Value of Holding European Patent Stocks*, 54 ECONOMETRICA 755, 774 fig.4 (1986). Similarly, Jean Olson Lanjouw, who studied a sample of over 2000 German patents filed between 1953 and 1988, reported that fewer than 50% of the patents were maintained for more than ten years, and fewer than 35% reached the statutory expiration date. Jean Olson Lanjouw, *Patent Protection in the Shadow of Infringement: Simulation Estimations of Patent Value*, 65 REV. ECON. STUD. 671, 693 (1998).

[50] PERFORMANCE AND ACCOUNTABILITY REPORTS, *supra* note 4.

* Figures from 1994 and 1996 appear to have been rounded to the nearest whole percentage point before inclusion in their respective reports.

** The Performance and Accountability Report for fiscal 1995 reported estimated figures for renewal data, and that actual third stage renewals were higher than expected.

Maintenance fees (required for renewal) are currently $830 at 3.5 years (First Stage), $1,900 at 7.5 years (Second Stage), and $2,910 at 11.5 years. 35 U.S.C. § 41(b) (2000).

[51] The reason is quite straightforward: if the return on successful or valuable patents is very high, then the average expected value of a patent may also be high despite the relatively low success rate.

[52] *See, e.g.*, Erwin F. Berrier, Jr., *Global Patent Costs Must Be Reduced*, 36 IDEA 473, 476-77 (1996) (estimating the cost of prosecuting a typical patent application at $14,370); Jon D. Grossman & Eric Oliver, *A Step-by-Step Guide to Prosecuting Business Method Patents*, COMPUTER LAW., Mar. 2000, at 6, 9 ("[T]he median cost of preparing and prosecuting a utility patent application approaches $15,000 in legal fees alone."

ternational protection, these amounts should be revised upwards by several orders of magnitude.[53] While the cost of patent prosecution is not inconsequential for many inventors, it is dwarfed by the cost of patent litigation. According to a survey conducted by the American Intellectual Property Law Association, the median cost of patent litigation is $799,000 for each party through the end of discovery, and $1,503,000 each through the end of trial and appeal.[54]

What about the expected value of patents? Despite the popular tendency to equate patents with supra-competitive monopolistic rents and the occasional media reports of decisions awarding astronomical damages to patentees in infringement cases,[55] the actual value of a patent is likely to be rather low. The empirical data about the value of patents is clearly at odds with the popular belief that patents are modern day gold mines. In a 1986 study of over 1 million European patents, Ariel Pakes concluded that the typical value of patents is usually low. He found that on average 50% of patents in France, Germany, and the U.K. are worth less than $2189, and that 90% of the patents have a value of less than $25,000.[56] A 1998 study by Mark Schankerman echoes Pakes' findings.[57] Using renewal data, Schankerman estimated the mean patent value at $4313 for pharmaceutical patents,

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(citing the 1997 American Intellectual Property Law Association (AIPLA) Economic Survey of Patent Lawyers) (assessing the typical charges for intellectual property applications based on location)); Wayne M. Kennard, *Obtaining and Litigating Software Patents*, 430 PLI/PAT 193, 208 (1996) (suggesting that the cost of drafting a software patent application is between $10,000 and $30,000 and that the cost of prosecuting it is another $10,000 to $20,000). As Mark Lemley correctly notes, these estimates fail to account for "either appeals or interferences, which obviously raise the cost a great deal." Lemley, *supra* note 3, at 1498 n.13.

[53] For example, Berrier estimates that the cost of obtaining protection in ten European countries is typically over $95,000. Berrier, *supra* note 52, at 479.

[54] AIPLA REPORT OF ECONOMIC SURVEY (OF U.S. IP PRACTITIONERS) (1999), *cited in* Craig P. Opperman, *Computer Technology Patents (with an Emphasis on Internet & E-Commerce Related Patents)*, 590 PLI/PAT 1039, 1047 (2000).

[55] *See, e.g.*, Verne Kopytoff, *Judge Orders EBay To Pay $29.5 Million*, S.F. CHRON., Aug. 7, 2003, at B2 (reporting verdict against EBay for infringing the patents of a Virginia company); John F. Manser, *Small Electronics Company Zaps Motorola: Power Integrations Wins $32.3 Million Award in Patent Case*, DEL. L. WKLY., Oct. 26, 1999, at 1 (reporting a $32 million dollar verdict, which the patent holder threatened to triple to almost $100 million because the infringment was allegedly willful).

[56] Pakes, *supra* note 49, at 777.

[57] Schankerman, *supra* note 1, at 94. All amounts are in 1980 U.S. dollars. It is noteworthy that the median values are much lower.

$4969 for chemical patents, $15,120 for mechanical patents, and $19,837 for electronics patents.[58]

Table 2: Estimates of Patent Value[59]

Quantile	Pharma-ceuticals	Chemicals	Mechanical	Electronics*	All-technology
0.25	515	447	638	627	557
0.5 *(median value)*	1631	1594	2930	3159	2329
0.75	5427	5807	13,769	16,322	10,331
0.90	11,787	13,735	40,840	53,122	29,871
0.95	19,920	24,363	83,857	113,403	60,386
0.99	52,139	69,906	321,966	481,429	231,360
Mean	4313	4969	15,120	19,837	11,060

*All amounts are in 1980 U.S. dollars. * Excludes Japan.*

Notwithstanding the high private cost of patent protection and the relatively low expected value of individual patents, the number of filings in the U.S. (and worldwide) continues to increase.[60] Perhaps even more surprising is the fact that many of those responsible for the increase in the number of filings are large corporations that are supposed to be patent pundits.[61] Finally, it is apparent that corporations, such as IBM, pride themselves on the number of patents they have been able to secure and emphasize the attainment of new patents in press releases and correspondence to shareholders.[62]

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[58] *Id.* Both economists pointed out that the distribution of patent values is highly skewed on account of a small number of highly valuable patents. Pakes, *supra* note 49, at 779; Schankerman, *supra* note 1, at 93-94.

[59] Values are taken from Schankerman, *supra* note 1, at 95 tbl.5.

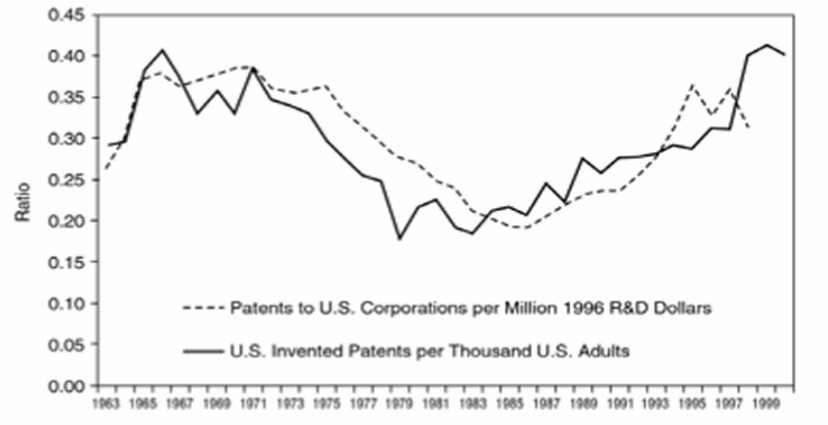
[60] USPTO Performance and Accountability Report for Fiscal Year 2003, *supra* note 50, at 107.

[61] For data showing the increasing percentage of patents obtained by private corporations, see PATENT TECHNOLOGY MONITORING DIVISION, U.S. PATENT AND TRADEMARK OFFICE, SPECIAL REPORT: ALL PATENTS, ALL TYPES, JANUARY 1977 – DECEMBER 2004 A1-1 (2005), *available at* http://www.uspto.gov/web/offices/ac/ido/oeip/taf/apat.pdf.

[62] *See, e.g.*, Press Release, IBM, IBM Breaks U.S. Patent Record: Tops List for Eleventh Consecutive Year—More Than 25,000 IBM Innovations Patented Since 1993 (Jan. 12, 2004), http://www.ibm.com/industries/education/doc/content/news/pressrelease/992547110.html (discussing IBM patent record); *see also infra* Part III.B (IBM case study).

Figure 1: The Recent Rise in Patent Filings[63]

Figure 2: The Rise in Patent Intensity[64]



It is abundantly clear that firms act as though patents are important. But why? Filing patterns and firms' attitudes toward patents have presented theorists with a puzzle: if patents are valuable, where does their value lie? And if they are not valuable, as the empirical research suggests, why do they matter so much to both corporations and

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[63] USPTO Performance Accountability Report: Fiscal Year 2003, *supra* note 50, at 107.

[64] A PATENT SYSTEM FOR THE 21ST CENTURY, *supra* note 2, at 30 fig.2-2.

investors? Following convention, we refer to this puzzle as the patent paradox.

It may be tempting to treat the patent paradox as yet another example of bounded rationality, perhaps even the primary one. On this theory, patenting patterns represent irrational behavior on the part of corporate managers and investors, presumably stemming from their systematic failure to grasp the limited value of individual patents.[65] Despite the surface appeal of this theory, we cannot subscribe to it. Given that virtually all the corporations that engage in intensive patenting operate in highly competitive industries, and that many of them are Fortune 500 companies, it is highly unlikely that such irrational behavior could persist for so many years without grave economic consequences. Surely, if the cost of patenting outweighed the benefit, companies that heavily rely on patent protection would put themselves at a competitive disadvantage and gradually lose their market share to rivals that abstain from patenting. Yet, this is not borne out by reality. Furthermore, all firms seem to actively seek patent protection. Hence, we reject the hypothesis that the patent paradox is born of illogical decision making. We are not alone. As we show next, none of the academic theorists who have addressed the patent paradox have considered bounded rationality to be an adequate explanation.

B. *The Scholarly Response to Date: Existing Explanations and Their Shortcomings*

Not surprisingly, the patent paradox has not escaped the attention of legal scholars and economists. While most scholars have found it sufficient to merely note the puzzle (almost in passing), a few theorists have taken the road less traveled and ventured to produce theoretical responses that seek to explain the patent paradox. In the remainder of this subsection, we review these responses and critically evaluate them. Although we conclude that none of these models does an adequate job of explaining away the patent paradox, we would like to emphasize at the outset that our goal is not to discard these theories. On the contrary, we believe that each of the works we review made a valuable contribution to the patent literature and that each correctly captures certain aspects, although not the totality, of the modern patent system. Furthermore, in Part IV.B, we show how some of the insights made in prior contributions can be reconceptualized through the prism of our patent portfolio theory.

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[65] *See, e.g.*, Korobkin, *supra* note 12 (arguing that bounded rationality affects purchasing decisions); Tor, *supra* note 12 (discussing bounded rationality in the context of market-entry decision making).

1. Patent Signals

In an excellent recent article, Clarisa Long suggests that the value of patents inheres not so much in the exclusivity they confer upon inventors, but rather in their ability to serve as credible signals. Challenging the traditional view that exclusivity, and the rents associated with it, are "the alpha and omega of the private value of patent rights,"[66] Long argues that firms use patents to "credibly convey information about the invention to observers who otherwise might not be willing to expend the costs necessary to obtain the information."[67] Stated more generally, patents are valuable because they "reduc[e] informational asymmetries between patentees and [third parties]."[68]

But what information do patents convey? Long maintains that patents provide two types of information: (1) information about the patented invention and (2) information about the patenting firm.[69] As for the first kind, Long points out that patents are publicly available documents that contain abundant information about an invention. And since the law imposes severe penalties on intentional misrepresentation of material information in a patent application, observers know that "the information contained in a patent has some credibility."[70] The second type of information signaled by patents is admittedly somewhat more oblique. Relying on previous academic research, Long explains that patent counts are likely to be positively correlated with other "less readily measurable firm attributes such as knowledge capital," and hence may serve as a proxy for these other attributes.[71] Under this theory, the cost of acquiring patent protection ensures the effectiveness of a patent as a signaling device. Since patents are costly to obtain, low-quality firms would find it difficult to imitate the signals of high-quality firms.[72]

We begin our critique with the first type of signal mentioned by Long—information about the patented invention. The main problem with this signal is that it does not get around the patent paradox. Per

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[66] Long, *supra* note 1, at 627. It should be noted, in fairness, that later in the article, Long clarifies that she does not dispute that the exclusivity associated with patent rights is important. *Id.* at 637.

[67] *Id.* at 636.

[68] *Id.* at 627.

[69] *See id.* at 647 ("Patents and portfolios can convey information about the invention and the firm.").

[70] *Id.* at 650.

[71] *Id.* at 627, 651-52.

[72] *See id.* at 657 ("Obtaining patents may be an effective signal that is hard for boring firms to mimic because the cost of obtaining patents deters boring firms from attempting to signal in this manner.").

our prior discussion,[73] the expected average value of individual inventions is very low, a premise that Long herself accepts.[74] Given this fact, it is not clear how information about individual inventions is valuable to third parties. Or, put more generally, why should the market care about information regarding a virtually valueless commodity? Indeed, it could even be argued that, given the low expected value of the average individual invention, third parties might be well-advised to ignore patents. Long's theory would be more compelling if she were able to show that third parties have an effective way of distinguishing the few high-value inventions from the rest of the pack. However, she does not make any such suggestion, and indeed, there seems to be no a priori reason to assume that third parties have an informational edge over patenting firms that would enable them to better estimate the value of patents. In fact, the opposite is likely to be true: patentees are very familiar with the unique characteristics of the markets in which they operate and hence are in a better position to assess the commercial success of their inventions.

Furthermore, patent applications convey little information about the potential commercial value of the invention. For example, patentees do a notoriously poor job of referencing prior inventions in their patent applications.[75] Without information about competing technologies and blocking patents, third parties cannot possibly determine the value of the patented invention. Finally, the potential signaling value of the patent application is further weakened by the lax and "patent-friendly" review given by the PTO (which approves nearly all of the applications that it receives).[76] Moreover, after passing this diminished level of scrutiny, a significant percentage of issued patents are declared invalid when challenged in court; hence, third parties cannot rely too heavily on the validity of issued patents that have not been exposed to litigation. Indeed, even Long acknowledges

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[73] *See supra* Part I.A.

[74] *See* Long, *supra* note 1, at 626 ("[W]hen the value of intellectual property rights in framed purely in terms of exclusivity and rents, worthless patents abound.").

[75] *See, e.g.*, 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, 589-90 (1999) (discussing the poor quality of patent applications in terms of the number and nature of prior art references).

[76] *See, e.g.*, Cecil D. Quillen, Jr. & Ogden H. Webster, *Continuing Patent Applications and Performance of the U.S. Patent and Trademark Office*, 11 FED. CIR. B.J. 1, 3 (2001) (indicating that once continuing applications are included, the patent approval rate is 95%). Quillen and Webster conclude that the PTO might ultimately approve as many as 97% of all patent applications. *Id.* at 13.

that in many circumstances patent signals may be ambiguous, in which case their value becomes suspect.[77]

As for the second signal, that of patent counts, it seems at first glance that Long treats the signaling value of patent counts as no more than the sum of the signaling values of individual patents in the portfolio.[78] For the reasons discussed above,[79] this theory cannot carry the day. If the signaling value of each individual patent is virtually nil, aggregating the value of the individual signals still leaves one with very little, if anything at all. However, in later discussion, Long seems to touch on the possibility that patent counts may be capable of signaling more than individual patents. Specifically, she suggests that an overview of all the patents a firm has "can convey information about the lines of research a firm is conducting and how quickly the research is proceeding," as well as signal other firm characteristics.[80] Here, Long is clearly on to something. Patent counts do signal information about the firm. However, as we discuss in Part II, the lion's share of the value of patent counts, or portfolios, lies not in their signaling function, but rather in the rents they generate for their holders. The signaling value of patent counts is simply a minor component of the framework we devise.[81] Furthermore, we are also able to demonstrate that the most important information signaled by patent portfolios is not so much about research lines but rather about the ability of the holder to understand the modern patent system and to take advantage of it.[82] Therefore, our theory plays up the very aspects that Long attempts to play down.

2. Patents as Internal Metrics

Recognizing that patents are a relatively ineffective means for capturing value, economist Richard Levin, alone and together with others, has suggested that patents may serve important intra-firm purposes; specifically, he proposes that patents might be used to measure

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[77] See Long, *supra* note 1, at 659 ("[P]atents and portfolios may be ambiguous signals that create a pooling equilibrium.").

[78] *See id.* at 643-44 ("I first present a testable hypothesis that patents (and by extension, patent portfolios) could reduce information asymmetries by directly conveying information about the invention and the firm at low cost and by serving as a signal of firm attributes that are deemed positive by observers.").

[79] *See supra* Part II.A.

[80] Long, *supra* note 1, at 646.

[81] *See* Ariel Pakes & Margaret Simpson, *Patent Renewal Data*, 1989 BROOKINGS PAPERS ON ECON. ACTIVITY: MICROECONOMICS 331, 365 (noting that "patent counts are a very noisy measure of the value of patented output").

[82] *See infra* Part IV.B.

employee productivity.[83] Agency theory suggests that employees, as agents, have an inherent incentive to shirk their duties if left to their own devices.[84] Accordingly, one of the challenges facing employers is to accurately gauge the performance of their employees. In the context of research and development, it is virtually impossible to directly measure employee effort, and the only quantifiable parameter is results. A natural way to approximate successful results is to look at patent filings. Therefore, patents are valuable insofar as they serve as a metric for evaluating employee productivity.

On its face, the internal metric theory has some obvious appeal. After all, measuring employee productivity is a tricky task, and the PTO is an impartial evaluator whose decisions are not tainted by favoritism toward certain employees. Upon closer inspection, however, the internal metric theory unravels. Indeed, it falls prey to the patent paradox that it set out to explain. Given the low private value of individual patents, it seems problematic to equate patent filings with successful job performance. Moreover, when the costs of obtaining protection are added to the calculus, one may even wonder why employees who produce a higher number of patents deserve to be rewarded. In light of the patent paradox, it could even be argued that R&D employees who engage in massive patenting are wasting valuable resources and should channel their energy and productivity to other ends. Another problem with the internal metric theory is the fact that more than half of the patent applications filed list more than one inventor.[85] In cases of co-inventorship, the joint inventors are not required to make equal contributions to the invention, nor is each required to collaborate on the subject matter of every individual claim.[86]

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[83] Levin, *supra* note 9, at 200-01. It should be noted that both works suggest other possible motivations for patenting such as improving one's position in bargaining and litigation. We discuss these motivations separately in Part I.B.4.

[84] *See, e.g.*, Armen A. Alchian & Harold Demsetz, *Production, Information Costs, and Economic Organization*, 62 AMER. ECON. REV. 777, 780 (1972) (discussing the incentive to shirk when the performance of individual team members cannot be easily monitored); *see also* ADOLF A. BERLE, JR. & GARDINER C. MEANS, THE MODERN CORPORATION AND PRIVATE PROPERTY 6 (1932) ("The separation of ownership from control produces a condition where the interests of owner and of ultimate manager may, and often do, diverge, and where many of the checks which formerly operated to limit the use of power disappear.").

[85] *See, e.g.*, John R. Allison & Mark A. Lemley, *The Growing Complexity of the United States Patent System*, 82 B.U. L. REV. 77, 96-97 (2002) ("[In the authors' random sample of 1000 utility patents issued between 1996 and 1998,] each patent listed 2.26 inventors on average, and the median patent listed two inventors.").

[86] *See* 35 U.S.C. § 116 (2000) ("Inventors may apply for a patent jointly even though . . . each did not make the same type or amount of contribution . . . ."); *see also* Burroughs Wellcome Co. v. Barr Labs., Inc., 40 F.3d 1223, 1227 (Fed. Cir. 1994) ("The

Rather, the standard is merely that each inventor must "generally contribute to the conception of the invention."[87] As a result, employers cannot reliably use patents to determine the precise participation of their R&D employees in the development of various patented inventions. Finally, patents are an unwieldy measure of productivity because the PTO ultimately approves almost all of the applications it receives,[88] creating a situation in which patent counts are easily manipulated. This would allow R&D employees so inclined (and agency theory suggests that most would be)[89] to over represent their productivity by simply increasing the number of applications they produce.[90]

3. The Lottery Theory of Patents

The lottery theory of patents, propounded by the economist F.M. Scherer, maintains that patents are essentially lottery tickets: while most have only a negligible value, a few are of such great financial consequence that they provide a sufficient incentive to inventors to obtain patents, based on the infinitesimal hope of receiving an extremely high payoff.[91] This theory follows from a more general conjecture made by Schumpeter that, although investors are generally risk-averse, they will often overrate their chances of success when presented with a sufficiently great potential reward. Thus, offering "spectacular prizes" to "a small minority of winners" is a more effective way to promote innovation, effort, and investment than a more equal distribution of benefits.[92]

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statute does not set forth the minimum quality or quantity of contribution required for joint inventorship.").

[87] Ethicon, Inc. v. U.S. Surgical Corp., 135 F.3d 1456, 1460 (Fed. Cir. 1998).

[88] *See* Quillen & Webster, *supra* note 76, at 3 ("[T]he number of original UPR applications allowed in fiscal years 1995-1998 was 95% of the number of original UPR applications filed in fiscal years 1993-1996.").

[89] *See supra* note 83 and accompanying text.

[90] We thank Ed Rubin for this point.

[91] Scherer, *supra* note 1, at 3. At least one court, in seeking to divide marital assets, has embraced the metaphor. *See* McDougal v. McDougal, 545 N.W.2d 357, 358 (Mich. 1996) (analogizing patents to "lottery tickets in the days before a drawing").

[92] Scherer, *supra* note 1, at 3 (quoting JOSEPH A. SCHUMPETER, CAPITALISM, SOCIALISM, AND DEMOCRACY, 73-74 (1942)). Scherer refers to the theory as the "skewness hypothesis." Professor Scherer finds empirical support for the proposition that the patent system functions as something of a lottery. Through several different empirical analyses, Professor Scherer finds that the distribution of value among individual patents (frequency versus economic value to their holders) follows a skewed distribution rather than a normal distribution, in which most of the total value of all patents comes from a few extraordinarily valuable patents, rather than an aggregation of patents with middling value. *Id.* at 7-12. His study of a sample of 776 German and 222 U.S. patents showed that, for both groups, the most valuable 10% of the patents ac-

The lottery theory has obvious limitations; while the lottery metaphor is illuminating, one should be wary not to stretch it too far. First, although the inventive process involves a significant degree of uncertainty and some degree of luck, it is far from being a true lottery. Unlike lotteries, which are completely random, the inventive process is knowledge based: ex ante information (such as technological know-how and industrial expertise) plays a key role, and to a large extent determines a company's likelihood of success.

Second, the lottery theory critically depends on the assumption that inventors, like lottery ticket buyers, are risk-seeking—indeed, so risk-seeking that they are willing to engage in an activity with a negative expected value. However, the standard assumption in the patent literature, as Scherer himself recognizes, is that investors are actually risk-averse.[93] To overcome this potentially fatal problem, Scherer reasons that after a certain point, at which the odds of success are infinitesimal and the potential reward sufficiently large, potential investors' enthusiasm increases with the absolute value of the possible reward without regard for the actual odds of success.[94] Alas, Scherer does not provide any direct empirical support for this argument.

Third, the lottery theory assumes that all inventors compete for the same prize. Yet in reality, this is not the case. Investment in R&D often results in a flurry of non-overlapping patented inventions. Furthermore, even corporations that have not captured any lucrative patents may nevertheless benefit from previous research as it puts them in a better position to compete for other inventions.

Fourth, the lottery analogy does not explain modern filing trends. By the time a company files for a patent, it can fairly accurately estimate the value of that patent. At the conclusion of the R&D stage, a company can reasonably predict whether it has the next Prozac on its hands, or simply another low-value patent. Consequently, one would expect firms that have not arrived at lucrative inventions to cut back on their losses by forgoing the cost of obtaining patent protection. Yet even such firms by and large prefer to go ahead and patent. The lottery theory offers a contentious explanation for why companies engage in R&D in the first place. However, it does not even begin to ex-

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counted for over 80% of the total value of the entire sample. *Id.* at 8. Finding similar results in other types of investments in high technology, Scherer shows that the value of investments in high technology generally is driven more by the "spectacular winners" at the statistical fringes, rather than an aggregation of investments of middling value. *Id.* at 18.

[93] *Id.* at 15. *But see* Sean T. Carnathan, *Patent Priority Disputes—A Proposed Re-Definition of "First-to-Invent,"* 49 ALA. L. REV. 755, 808 (1998) (asserting that "inventors are likely among the least risk-averse people on the planet").

[94] *See* Scherer, *supra* note 1, at 18 (suggesting that investors can be "simultaneously variance-averse and skewness-loving").

plain various other salient features of the modern patents system. Indeed, in Part IV.B, we show that the lottery theory misses some of the key effects of patents and thus can lead to a distorted view of the patent world. For example, the lottery theory suggests that "losing ticket" patents (which constitute the vast majority of patents issued) would simply fall by the wayside. Firms should have no use for such patents, and hence they should play no role in incentivizing firms to engage in R&D. Yet as we demonstrate in Part II, and as leading technology firms have already come to recognize, even these "losing ticket" patents yield significant value.

4. Defensive Patenting

The defensive patenting theory is, in a way, the flipside of the lottery theory. While the lottery theory views patents as high-risk investments, the defensive patenting theory views them as a type of insurance. Under this theory, the acquisition of patents is something of an arms race, whereby competing firms use patents as bargaining chips to negotiate with competitors and to secure certain niches in the marketplace.[95] The defensive patenting theory is based on the assumption that the Federal Circuit has strengthened patent rights in such a way to make the threat of patent litigation significantly more potent, thus altering firms' incentives to patent.[96] Even though patents themselves have not become any more valuable, in the sense of appropriating returns to research and development,[97] they have somehow become more valuable as the subject matter of potential litigation. Thus, the defensive patenting theory holds that firms acquire patents to ward off possible lawsuits by using the patents as bargaining chips with poten-

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[95] *See* Hall & Ziedonis, *supra* note 1, at 104, 125 (discussing the use of patents in the semiconductor industry and formulating a "strategic response" hypothesis about the utility of patents); Rosemarie Ham Ziedonis, *Patent Litigation in the U.S. Semiconductor Industry*, *in* PATENTS IN THE KNOWLEDGE-BASED ECONOMY, *supra* note 1, at 180 (updating some of the data from the Hall & Ziedonis study and examining the enforcement behavior of U.S. semiconductor firms). Hall and Ziedonis's defensive theory of patents is based on research that used U.S. semiconductor firms as a case study.

[96] *See* Hall & Ziedonis, *supra* note 1, at 105-07 (linking the "surge in patenting" in the United States to the 1982 creation of the Federal Circuit); Ziedonis, *supra* note 95, at 188-89 (same).

[97] *See* Hall & Ziedonis, *supra* note 1, at 102 ("R&D managers in semiconductors consistently report that patents are among the *least* effective mechanisms for appropriating returns on R&D investments."); Ziedonis, *supra* note 95, at 181 (citing survey evidence suggesting that "firms in most industries have *not* increased their reliance on patents for appropriating returns to R&D over the decade of the 1980s").

tial plaintiffs.[98] Even the firms that threaten others with litigation often do so in the hope of securing a cross-licensing agreement with the potential defendant, so that the potential defendant will not later sue the potential plaintiff on another patent.

The defensive patenting theory has considerable explanatory power. It is grounded in empirical research and, in our opinion, accurately captures certain elements of the patent world. Nevertheless, it can be criticized on two grounds. First, the defensive patenting theory focuses on only the defensive uses of patents, while ignoring the important offensive uses conferred with patent rights. Like Long's theory of patent signals, defensive patenting does not consider patents as an effective means of appropriating returns. Due to this narrow prism, defensive patenting ignores many of the affirmative ways by which patents generate returns to inventors. Second, the defensive patenting theory does not discuss how the defensive effects of patents vary along different patent portfolios. This is a key omission. As we show in Part II, the defensive force of patents critically depends not simply on the number of patents, but also on the design of the patentee's portfolio.

II. A THEORY OF PATENT PORTFOLIOS

Having argued that the prior theories addressing the patent paradox are incomplete, we turn in this Part to the development of an alternative view—one that offers richer opportunities for understanding the meaning and implications of the patent paradox. The fundamental argument here is that the real value of patents lies not in their individual significance, but instead in their aggregation into a patent portfolio: a strategic collection of distinct-but-related individual patents that, when combined, confer an array of important advantages upon the portfolio holder.[99] We find that the benefits of patent port-

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[98] *See* Hall & Ziedonis, *supra* note 1, at 109-10 (attributing aggressive patenting trends to companies' desire to deter litigation); Ziedonis, *supra* note 95, at 208 (noting an increasing trend in "directing a larger share of their innovation-related resources toward defending, enforcing, and challenging patents in court").

[99] The value of patent portfolios has been widely recognized in commercial circles, but has received little attention (and virtually no discussion of its implications outside of antitrust) in the legal-academic literature.

For examples of recognition of the commercial value of patent portfolios, see Gary M. Hoffmann, *Turning Your Intellectual Property Assets into Cash*, *in* HANDLING INTELLECTUAL PROPERTY ISSUES IN BUSINESS TRANSACTIONS 2003, 740 PLI/PAT 1005, 1019-20 (Practicing Law Institute ed., 2003) (noting the additional value conferred by covering various potential variations of the invention in a "multitude of patents" rather than in a single patent); Carolina Braunschweig, *Nano Nonsense*, VENTURE CAP. J., Jan. 1, 2003, at 18, 24 (noting the business goal of some young companies in the nanotechnology industries to build patent portfolios); Cathryn Campbell, *Patenting the Tools of*

folios are substantial enough to encourage patenting behavior irrespective of the expected value of the underlying individual patents themselves; the marginal expected gain in value of adding an additional patent to a well-crafted patent portfolio will almost invariably exceed the marginal cost of acquisition.[100] We argue that this theory

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Biotechnology, VENTURE CAP. J., May 1, 2003, at 33, 34 (asserting that "numerous examples are available which demonstrate that strategically planned and well-managed patent portfolios can be financially profitable," and citing the successful biotechnology portfolio of the Dyax Corporation as one such example); John Cox, *As Patent Suits Proliferate, So Do Worries*, NETWORK WORLD, Aug. 18, 2003, at 8, *available at* http://www.networkworld.com/news/2003/0818patents.html (linking an apparent rise in patent suits in computer technology to increasing development of patent portfolios); Michael Kenward, *Displaying a Winning Glow*, TECHNOLOGY REV., Jan./Feb. 1999, at 68, *available at* http://www.techreview.com/articles/99/01/kenward0199.asp (describing Cambridge Display Technology, a startup company that is using its patent portfolio to build alliances and carve out a commercial position in the LED industry); David Kline, *The New Gold Rush in Patents*, UPSIDE, May 1998, at 58, 58 ("In the four years since IBM Corp. began a concerted campaign to make better use of its patent portfolio . . . the company has increased its annual patent license revenues from about $350 million in 1993 to more than $1 billion today."); Michael Mattis, *Aurigin Systems Sees Gold in Intellectual Property*, UPSIDE, Aug. 1998, at 112, 114 (describing the company's efforts to build a software-based system to assist in managing and planning patent portfolio development and asserting that "most high-tech companies have only developed real patent portfolios during the past couple of years"); Eric Nee, *Qualcomm Hits the Big Time*, FORTUNE, May 15, 2000, at 213, 220 (describing how Qualcomm, by virtue of amassing a patent portfolio related to CDMA wireless technology, can require "any company that makes CDMA products, be they chips, phones, or infrastructure gear" to get a license); Tim O'Reilly, *The Internet Patent Land Grab*, COMMUNICATIONS OF THE ACM, June 2000, at 29-30 ("[T]he [patent] system is tilted heavily in favor of companies with large patent portfolios. As one lawyer from a company with a huge patent portfolio commented to me about Amazon.com: 'It's not a big company. It doesn't have enough patents to play this game.'"); David Raymond, *How to Find True Value in Companies*, FORBES, June 24, 2002, at 64, 64 (noting that a collection of stocks picked via the quality of a firm's patent portfolio appreciated at three times the rate of the S&P 500 from 1989 to 1998).

For more academic treatments, see John H. Barton, *Antitrust Treatment of Oligopolies with Mutually Blocking Patent Portfolios*, 69 ANTITRUST L.J. 851, 856 (2001) (citing examples—Motorola's GSM patent portfolio and Gemstar's interactive TV Guide portfolio—where "firms have gained very strong [market] positions primarily on the basis of portfolios"); Hall & Ziedonis, *supra* note 1, at 108–10 (finding, in an interview study, that a major driver of the construction of patent portfolios in the semiconductor industry was for defensive and bargaining-leverage purposes); Steven C. Carlson, Note, *Patent Pools and the Antitrust Dilemma*, 16 YALE J. ON REG. 359 (1999) (noting concerns with the insulation that large patent portfolios provide to their individual component patents).

For details of the relative benefits of patent portfolios, see *infra* Part II.B.

[100] Note that under the portfolio theory, such patenting decisions are made without direct reference to the net expected value of the individual patent. *See infra* Part II.C.

The average administrative costs of obtaining a U.S. patent are typically estimated to be in the range of $20,000. *See, e.g.*, Lemley, *supra* note 3, at 1498-99 (positing

provides the best explanation yet for modern patenting trends, which show a propensity for firms to patent even where the net expected value of obtaining the individual patent is likely to be zero (or even less).[101] Under the patent portfolio theory, such decision making is rational because individual patents are required inputs for the construction and maintenance of a patent portfolio. That is, in the modern patenting environment, the prosecution of an individual patent is best understood as a means to the commercially desirable end of a patent portfolio, rather than the end itself.

The theory of patent portfolios is outlined in three parts below. First, in Part II.A, we introduce the concept of a patent portfolio as a collection of distinct-but-related patents, providing a definitional basis for what follows. In Part II.B, we explain why the advantages of patent portfolios far exceed the value of individual patents, observing that well-crafted patent portfolios have features of both scale (broad protection of subject matter) and diversity (diminished reliance on any single patent) that enable portfolio holders to simultaneously wield significant marketplace power while hedging against the risk and uncertainty inherent in innovation-driven commercial activities. Part II.C links the advantages of patent portfolios to "the patent paradox," noting that because most of the advantages of patent portfolios are directly related to the quantity of constituent patents, and because high-volume patenting addresses key strategic challenges in the development of portfolios, firms can be expected to seek patents in quantities well beyond what would be supported by the net expected value of the individual patents themselves. That is, subject to some limits, additional patent prosecution is almost always the dominant decision.

A. *An Introduction to Patent Portfolios*

As used here, a patent portfolio is a collection of related patents, held under common control. In the patent portfolio theory, *relatedness* is an important feature: unlike corporate stock portfolios, for example, where broad diversification is a typical goal, patent portfolios are more narrowly focused within a technological field. This distinction is based on the knowledge of the portfolio holder. Whereas patent portfolios are paradigmatically held by knowledgeable industry or

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$20,000 as a "conservative average"); Mark A. Lemley, *Reconceiving Patents in the Age of Venture Capital*, 4 J. SMALL & EMERGING BUS. L. 137, 138 n.3 (2000) (estimating an average of $25,000). The recent National Science Foundation review of the patent system found that relatively simple prosecution cases will cost at least $7,500, and that more complex prosecution efforts cost in the tens of thousands of dollars. A PATENT SYSTEM FOR THE 21ST CENTURY, *supra* note 2, at 68 (2004).

[101] *See infra* Part IV.A.2.

technology players,[102] broadly diversified stock portfolios are well suited to holders that lack detailed information about any individual industry or technology. The additional focused expertise about the technology or industry allows patent portfolio holders to create far more narrowly focused collections of assets (here, patents).

But not too narrow: while patent portfolios consist of related patents, this is not to say that they are not diverse in any respect. Indeed, it is the ability to leverage the differences among collected patents that makes patent portfolios a powerful tool in the modern, innovation-driven marketplace.[103] Thus, a patent portfolio is best understood as a collection of individual patents that share critical technological features. A portfolio might be focused on a specific problem in a particular industry, such as techniques for using 90-nanometer and smaller conductors in semiconductor manufacturing.[104] Or it might be more process-based; for example, a bio-pharmaceutical patent portfolio might be targeted at the treatment of a specific disease in a specific way, such as the use of statins to address human cholesterol levels.[105] Or a portfolio might be more simply targeted at a specific individual product, such as a genetically modified agricultural product or a consumer electronics product. Whether process-based, problem-based, or product-based, the unifying concept of patent portfolios is their aggregation of related patentable inventions in a way that is coherently designed and directed. To be sure, collections of far less related or even completely unrelated patents can and do exist—some might even call them "portfolios"—but these random assortments are little more than that, and thus lack the power of a true patent portfolio.

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[102] *But see infra* Part III.C (discussing Gemstar's practice of acquiring patent-holding companies in order to create its own portfolio).

[103] *See infra* Part II.B.2 (describing the diversity-features of patent portfolios).

[104] *See, e.g.*, John Markoff, *Advanced Micro Narrows Gap in Race for New Chip*, N.Y. TIMES, Aug. 17, 2004, at C5 (reporting a new line of microprocessors being developed by competing technology companies).

[105] *See, e.g.*, *NBC Nightly News: Profile: Lifesaving Statins Too Expensive for Many Americans with Heart Problems to Afford* (NBC television broadcast Feb. 25, 2004) ("The statin drugs, including Zocor, Lipitor, and Pravachol, make up one of the great success stories of medicine. Study after study involving hundreds of thousands of people show the drugs dramatically reduce the risk of heart disease and stroke, even for people with cholesterol in the normal range."); *see also All-in-One Pills for Heart Disease*, HARV. HEALTH LETTER, July 1, 2004, at 3, 3 (discussing the trend of American pharmaceutical companies bundling their brand-name products into new combinations, which skeptics see as a marketing maneuver to entice people into buying brand name drugs, but which also gives the patent holder fresh patent protection on a new pill made of older drugs with patents that will expire much sooner).

Finally, while the patent portfolio theory does not require a specific quantity of patents to form a portfolio,[106] size does matter. Virtually all of the benefits of a patent portfolio sketched below are broadly proportional to the quantity of individual component patents involved. As noted in some detail in Part II.B.1 below, it is the "heft" of a patent portfolio—as measured in large part by the quantity of the patents comprising it—that fundamentally determines its effectiveness as a tool in the marketplace. Of course, the quantity of patents that comprise an effective portfolio is not limitless, and will, of course, depend upon a number of situation-specific factors, such as the technology involved, industry structure, the existence of competitive portfolios, and others. And there are likely to be diminishing returns from adding patents to a portfolio as its size increases beyond a certain point. But as a general matter, more is better; the benefits of patent portfolios increase with their scale—thus demonstrating the explanatory power of the patent portfolio theory in the modern patenting environment.

B. *Scale and Diversity: The Advantages of Patent Portfolios*

The benefits, many and varied, of patent portfolios to their holders in the modern commercial environment are currently better recognized in the business world than in academia.[107] As a general matter, these benefits can be divided into two broad categories: those that relate to scale-features of portfolios, and those that relate to diversity-features. The scale-features of portfolios spring from the observation that a well-conceived patent portfolio is in many ways a form of "super-patent," sharing many of the marketplace advantages conventionally attributed to individual patents (paradigmatically, rights to exclude others from the marketplace),[108] only on a larger, broader

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[106] Formally, any two or more related patents can qualify as a patent portfolio for our purposes.

[107] Throughout Part II.B, we demonstrate the commercial relevance of the patent portfolio theory by noting, via examples and citations, that many of the advantages that we identify have previously been recognized as important features of patent portfolios by major commercial players. *See, e.g.*, John P. Sumner & Steven W. Lundberg, *Software Patents: Are They Here to Stay?*, COMPUTER LAW., Oct. 1991, at 8, 9 ("Having a strong offensive and defensive patent posture is usually enabled not by a single patent but by a patent portfolio . . . . Thus it can be important to consistently obtain patent protection to leverage research and development dollars into long-term assets which eventually can blossom into a fence of protection.").

[108] *See* 35 U.S.C. §§ 154, 271 (2000) (describing patent enforcement rights); Cont'l Paper Bag Co. v. E. Paper Bag Co., 210 U.S. 405, 429 (1908) (holding that the power to exclude others is "the very essence of the right" conferred by patent law); Eldred v. Ashcroft, 537 U.S. 186, 216 (2003) ("[P]atents are not given as favors . . . but are meant to encourage invention by rewarding the inventor with the right, limited to a

scale. By aggregating the individualized value of a number of closely related patents, the scale-features of patent portfolios enable holders to realize true patent-like power in the modern marketplace to a degree which is impossible using individual patents alone.[109]

By contrast, while the scale-features of patent portfolios abstract away from their underlying structure, the diversity-features embrace it. That is, the diversity-features of patent portfolios reflect their status as the purposeful combination of distinct-but-related individual patents. For patent portfolios are not merely singular super-patents; instead, the inherent diversity created by the aggregation of many different patents offers holders a range of benefits—such as the ability to address the risk and uncertainty fundamental to innovation—that cannot be easily achieved absent the creation of such structures.[110]

Indeed, it is this dual quality of patent portfolios—the broad marketplace sweep of a super-patent, and the uncertainty-hedging ability of a diverse collection of assets—that both suggests the remarkable advantages of patent portfolios in the modern economy and explains their growing use.

1. Super-Patents: The Scale-Features of Patent Portfolios

In some ways, a collection of closely related patents defining a patent portfolio can be said to operate as a "super-patent" in much the same way that the holding of a U.S. patent grants the right to exclude others from the scope of its claims—the holding of a patent portfolio will allow the holder to exclude others from the *collective*

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term of years fixed by the patent, to exclude others from the use of his invention." (quoting Sears, Roebuck & Co. v. Stiffel Co., 376 U.S. 225, 229 (1964))); *see also* Kline, *supra* note 99, at 58 ("In the four years since IBM Corp. began a concerted campaign to make better use of its patent portfolio . . . the company has increased its annual patent license revenues from about $350 million in 1993 to more than $1 billion today.").

[109] *See, e.g.*, O'Reilly, *supra* note 99, at 30 (arguing that "the system is tilted heavily in favor of companies with large patent portfolios"); Edward E. David, Jr., *The University-Academic Connection in Research: Corporate Purposes and Social Responsibilities*, 64 J. PAT. OFF. SOC'Y 209, 211 (1982) (noting the relative importance of patent portfolios versus ownership of individual patents).

[110] The benefits of diversified portfolios have long been recognized in the field of asset management. *See* Harry Markowitz, *Portfolio Selection*, 7 J. FIN. 77 (1952) (introducing the concept of portfolio theory, for which Markowitz received the 1990 Nobel Prize in Economic Science); *see also* U.S. DEP'T OF THE TREASURY, REPORT OF THE DEPARTMENT OF THE TREASURY ON EMPLOYER STOCK IN 401(K) PLANS (2002), *available at* http://www.treas.gov/press/releases/reports/401(k).pdf ("Asset diversification is a bedrock principle of prudent long-term investing."); CHARLES P. JONES, INVESTMENTS: ANALYSIS AND MANAGEMENT 566 (4th ed. 1994) (discussing the Markowitz model and arguing that diversification is the number one rule of portfolio management); James K. Glassman, *Diversify, Diversify, Diversify*, WALL ST. J., Jan. 18, 2002, at A10 (arguing that employees should diversify their retirement portfolios).

scope of its claims.[111] Where such patents are both (patentably) distinct[112] yet cover coterminous subject matter,[113] the breadth of the right to exclude conferred by a patent portfolio is essentially the sum of the individual patent rights.

But the scale advantages of patent portfolios are more than merely additive. The broader protection conferred by patent portfolios offers a range of benefits to the holder different in kind as well as size from a simple collection of unrelated individual patents. We discuss some of these benefits out below.

a. *Eases Subsequent In-House Innovation*

Holding a patent portfolio allows a firm to more confidently proceed along an innovation path. The broader scope of protection ensures that a wider range of technological possibilities will be covered, which both increases the possibility that the end result of the research and development effort will be covered, and diminishes the concerns of infringement of others' patents.[114] This "freedom of movement"—the ability to invent, implement, produce, and ship products with in-house resources—is increasingly viewed as an advantage in today's dynamic market environments, where speed and flexibility are economic imperatives.[115]

b. *Attracts Related External Innovations*

The scale-features of patent portfolios also enhance the ability to consolidate and coordinate related technological developments within the holding firm.[116] The heft of a patent portfolio can provide

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[111] *See* 35 U.S.C. § 271 (2000) (defining patent infringement).

[112] *See* 35 U.S.C. § 102(e), (g) (2000) (barring double-patenting); *see also* Gen. Foods Corp. v. Studiengesellschaft Kohle MbH, 972 F.2d 1272, 1278-79 (Fed. Cir. 1992) (discussing the law of double-patenting).

[113] See discussion below regarding the challenges of portfolio construction.

[114] *See, e.g.*, Peter C. Grindley & David J. Teece, *Managing Intellectual Capital: Licensing and Cross-Licensing in Semiconductors and Electronics*, 39 CAL. MGMT. REV., Winter 1997, at 8, 9 ("The portfolio approach reduces transactions costs and allows licensees freedom to design and manufacture without infringement.").

[115] *See* David, *supra* note 109, at 209-19 (discussing the benefits of industry-supported research in universities). Apple Computer is also well-known for its ability to "stay ahead of the pack" by combining most features of innovation in-house. *See, e.g.*, Lee Gomes, *Portals: Apple Is Now Showing Some Real Substance Behind the Pretty Case*, WALL ST. J., Jan. 20, 2003, at B1 (noting that one way Apple abides by its own "Think Different" motto is by "insisting on doing both hardware and software in-house").

[116] This point has empirical support. *See* Donna J. Kelley & Mark P. Rice, *Leveraging the Value of Proprietary Technologies*, J. SMALL BUS. MGMT., Jan. 2002, at 1, 9-10 (finding statistical support for the relationship between patent portfolios and alliance formation in new, technology-based firms); *see also* Rajiv P. Patel, *Patent Portfolio Strategy for*

a firm with a strong market position (either real or perceived) in a particular field, thus encouraging upstart innovators to combine their inventions with that of a portfolio holder, rather than seeking to develop their own market niche.[117] Thus, holding a patent portfolio can have a multiplier effect on the range of innovations that can be accessed by the firm.[118]

c. *Avoids Costly Litigation*

By deploying a patent portfolio with a broad sweep of exclusivity in a particular field, the holder is likely to dramatically reduce its involvement in patent litigation. This is for several reasons. First, in cases where the portfolio holder believes that another has infringed, the broader total scope of protection created by the portfolio will only increase the chances that infringement will ultimately be proven, thus encouraging settlement. Second, where the portfolio holder is the potential infringer, the chances that the holder will have a cognizable counterclaim based on one or more of its own patents is much higher, especially if the patent portfolio in question covers a significant portion of the technological landscape—again, encouraging settlement rather than litigation.[119] Third, where there are potential opposing claims of infringement—that is, where both a portfolio holder and an individual patentee have counterclaims—the existence of a patent

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Start-Up Companies: A Primer, PAT. STRATEGY & MGMT., Nov. 2002, at 1, 1 (advocating that companies carefully build patent portfolios to gain "a variety of business objectives, such as bolstering market position, protecting R&D efforts, generating revenue, and encouraging favorable cross-licensing or settlement agreements").

[117] *See, e.g.*, Benjamin Pimentel, *Inventors Patent Ideas To Pre-Empt Their Rivals; Companies Then Must Buy Rights to the Devices*, S.F. CHRON., June 9, 2003, at E1 (discussing how it is easier to partner with a massive-portfolio holder such as IBM than it is to square off against them); *see also infra* Part III.B (discussing the size of IBM's patent portfolio).

[118] *See, e.g.*, Larry Horn, *Alternative Approaches to IP Management: One-Stop Technology Platform Licensing*, J. COM. BIOTECH., Jan. 2003, at 119, 119 (citing the example of the MPEG LA licensing scheme as a way to provide "the marketplace with fair, reasonable, nondiscriminatory access to a portfolio of worldwide essential patents under a single license"); *see also* Kelley & Rice, *supra* note 116, at 2 ("We maintain that by building a portfolio of technologies, the value of which can be communicated to others, a firm can offer something unique to potential partners and in turn capture advantage from the proprietary resources of these partners.").

[119] The increased incentives to settle in this case come both from the increasing chances that the portfolio holder will win the case as well as the dramatically raised stakes in the litigation, which will encourage risk-averse parties to settle.

This point, like most others in this section, is recognized in the commercial world. *See, e.g.*, John J. Egan & Ray Lupo, *Protecting Venture Investments Against Patent Litigation*, VENTURE CAP. J., Dec. 1, 2002, at 40, 41 ("A strong patent portfolio may even prevent a company from being accused of patent infringement in the first place, because a competitor may see too much risk in suing a company holding a strong patent portfolio.").

portfolio creates a potential imbalance in both the stakes of the litigation and the likelihood of success, which again encourages settlement rather than litigation. And fourth, where multiple portfolio holders operate in a particular field, the greatly increased stakes—and increased chances that both parties would be found liable—will diminish the appeal of litigation as a method of dispute resolution. Thus, in all scenarios, the existence of a patent portfolio (or multiple portfolios) can be expected to help holders to avoid patent litigation. In addition, note that this litigation-avoidance effect will be more pronounced in proportion to the uncertainty surrounding individual patents, because the multiplier effect of the patent portfolio will tip the balance away from the 50-50 split that maximizes the possibility of litigation—and, of course, this shift will always be in favor of the portfolio holder.[120]

d. *Improves Bargaining Position*

Holding a significant patent portfolio can improve the holder's bargaining position along several dimensions. First, and most obviously, the scale-effects of the portfolio—the quantity of potential infringement claims, and the increased net likelihood that at least some such claims will be successful—offer a powerful leveraging tool that can improve the holder's position with respect to competitors.[121] But

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[120] *See, e.g.*, George L. Priest & Benjamin Klein, *The Selection of Disputes for Litigation*, 13 J. LEGAL STUD. 1, 15-16 & fig.6 (1984) ("Figure 6 illustrates how the settlement negotiations of potential litigants select disputes for litigation."). As long as a portfolio of litigated patents was not completely covariant (which, under the patent law, they cannot be), the likelihood of success—winning one patent litigation—for the portfolio holder rises as the number of litigated patents increases, even if the average possibility of winning on the basis of any single patent is rather low. For example, the likelihood of success (assuming independence among the litigated patents) is 1-p(loss)N, where p(loss) is the average loss probability for single patents, and N is the number of patents litigated. Even assuming an average loss probability of 75%, a portfolio of just three patents would bring the likelihood of success to the portfolio holder above 50% (to 58%). Note, of course, that the assumption of true independence is too strong: patents in a portfolio are by definition related, and certainly would have to be similar to be involved in a common litigation strategy. But the basic point, we think, holds: as portfolio size increases, the likelihood of success in the courts increases.

Additionally, while it is possible that the existence of a portfolio could in some cases bring the odds of victory closer to 50%, our point is that where there is distinct uncertainty—true equipoise in odds of success—the presence of a portfolio will likely tip the scale (in favor of the patentee). Again, assuming an average loss probability of 50%, litigating two patents implies a 75% likelihood of a win to the portfolio holder. Thanks to Dave Castleman for clarifying this point with us.

[121] Nee, *supra* note 99, at 220 (reporting analyst views that because "[m]ost large companies . . . have patent portfolios of their own . . . big players within an industry often sign cross-licensing agreements that let them use one another's technology without paying fees").

holding a patent portfolio will also be beneficial in dealings with other players in the marketplace.[122] For example, as noted above, a portfolio holder will be a particularly attractive partner for firms dedicated to improving or extending existing technology: the strong market position established by a significant portfolio will both improve the chances for success of any follow-on products, as well as diminish the possibility for advancement where an agreement is not reached. Note as well that this same marketplace advantage means that the portfolio holder will also have an improved position vis-à-vis others in the product chain, such as suppliers and distributors. Thus, one can expect portfolio holders to be able to reach more beneficial arrangements with a variety of parties.[123]

e. *Improves Defensive Positions*

Patents, of course, can play a defensive rather than offensive role—serving to dissuade litigation (and threats thereof) by others in the field, because of the threat (real or implied) of retaliatory litigation.[124] As we noted above, however, the relative lack of value of individual patents calls into question their defensive (as well as offensive) utility. Patent portfolios, on the other hand, can address this concern: the scale-effects of a portfolio mean that the broader array of possible infringement claims (and the concomitant greater net likelihood of success) allow significant patent portfolios to serve as important defensive mechanisms in a highly litigious environment.

f. *Increases the Firm's Voice in the Politics of the Patent System*

As the U.S. patent system gains prominence for its importance in regulating the innovation-driven modern economy, the politics of the patent system become increasingly contentious and polarized.[125] Ac-

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[122] *See, e.g.*, Patel, *supra* note 116, at 1 (asserting that a well-crafted portfolio can encourage cross-licensing as well as settlement agreements with other companies).

[123] *See, e.g.*, David Rohde, *Lucent Hardball*, NETWORK WORLD, Mar. 22, 1999, at 75 (reporting a competitor's claim that Lucent Technologies is using its patent portfolio in older technologies "as large bargaining chips to cross-license what it doesn't have, and sometimes mount some rather formidable barriers against competition").

[124] *See, e.g.*, John H. Barton, *Antitrust Treatment of Oligopolies with Mutually Blocking Patent Portfolios*, 69 ANTITRUST L.J. 851, 855 (2002) (describing the practice in the semiconductor industry of acquiring patent portfolios for their defensive benefits).

[125] *See, e.g.*, OXFAM INT'L, OXFAM BRIEFING PAPER 56, ROBBING THE POOR TO PAY THE RICH? HOW THE UNITED STATES KEEPS MEDICINES FROM THE WORLD'S POOREST (2003), *available at* http://www.oxfam.org/eng/pdfs/pp031201_robbing_medicines_US.pdf (criticizing United States patent policy in developing countries); Electronic Freedom Foundation, The Patent-Busting Project, http://www.eff.org/patent/ (promoting the invalidation of allegedly illegitimate patents); *Update: Bush to Close Hatch-*

cordingly, having a "seat at the table" during any negotiations concerning patent law changes is (and will increasingly be) important to the modern firm. Holding a significant patent portfolio can ensure that firms are viewed by regulators and legislators as "players" in the patent debates.[126]

g. *Enhances Efforts to Attract Capital*

The scale-effects of patent portfolios will improve holders' ability to attract and retain capital investment. Unlike individual patents, a significant patent portfolio is (for the reasons noted above, and others) a substantial asset. Further, while the dubious value of individual patents calls into question their ability to provide meaningful signals about the firm to external parties, patent portfolios do not suffer from this defect—and thus will provide information to the capital markets about the competitiveness, savvy, and long-term prospects of the holding firm.

* * *

In short, the scale-features of patent portfolios—the increased breadth of protection and the corresponding net increase in the likelihood of successfully enforcing the scope of protection—offer a number of (mostly familiar) benefits to the holder. In an environment where individual patents are increasingly of questionable value, it is the patent portfolio that is assuming the role of providing meaningful patent-type protection in the modern marketplace.

2. The Diversity-Features of Patent Portfolios

The benefits of patent portfolios, however, go well beyond their status as de facto super-patents. For patent portfolios are not simply singular items, but rather a constructed array of related-but-distinct individual patents, with each component patent representing a frac-

Waxman Loopholes, PHARMA MARKETLETTER, Oct. 28, 2002, at 1 (quoting President Bush advocating stronger patent protection for drug companies); Maureen O'Gara, *Anti-Patent Banner Raised*, LINUX BUS. NEWS, Aug. 18, 2003, http://www.linuxbusinessweek.com/story/35312.htm (discussing patent disputes in the open source movement). For more broad-based patent reform proposals, see FED. TRADE COMM'N, TO PROMOTE INNOVATION: THE PROPER BALANCE OF COMPETITION AND PATENT LAW AND POLICY (Oct. 2003), *available at* http://www.ftc.gov/os/2003/10/innovationrpt.pdf (recommending standards and procedures for evaluating questionable patents); A PATENT SYSTEM FOR THE 21ST CENTURY, *supra* note 2, at 103 (discussing the benefits of a new procedure for reviewing patent validity).

[126] Admittedly, it might be possible to achieve much of this benefit without having a purposefully constructed portfolio, but instead simply having a large number of perhaps unrelated patents.

tion of the total. This diversity—the fact that no single patent determines the value—is a major benefit of patent portfolios. By distributing the importance of the total portfolio across the constituent individual patents, a patent portfolio allows holders to significantly hedge against aspects of risk and uncertainty that are endemic to innovation in the modern economy. Specifically, note the following benefits of the diversity of patents in a portfolio.

a. *Addresses Ex Ante Uncertainty Related to Technology*

Innovation is a notoriously uncertain business, with no guarantees of success and often little visibility concerning future conditions. Firms operating in an innovation-driven environment understand that future technological developments will make or break their research and development efforts: an early decision to pursue a particular technology or research path can, perhaps years later, turn out to be prescient or misguided. Patent portfolios can help ameliorate some of this uncertainty by allowing holders to secure protections along a broader swath of the technological-development path than would be possible with individual patents alone. For example, suppose that a firm decides to pursue a development path for semiconductors that includes the use of a newly developed material to replace the silicon substrate. By developing a patent portfolio focused on a range of types or features of materials, the firm can address the obvious ex ante uncertainty about the precise nature of the material that will ultimately be successful as development continues. Indeed, a portfolio-driven strategy will lead a firm to seek patent protection not only for materials that it considers most likely to yield results, but for as many distinct-but-related materials as reasonably possible.[127] A substantial, well-planned patent portfolio allows a holder to seamlessly adjust for changing technology as it attempts to navigate the path of a research and development effort.

b. *Expands the Freedom of Research Inquiry*

A closely related benefit of patent portfolios is that they allow holders to expand the avenues of their technological development ef-

[127] *See* 35 U.S.C. § 112 (2000) (describing disclosure requirements for patent applications). Because at least nominal research must be conducted to support patenting, a portfolio-driven strategy would thus encourage firms to either (a) broaden—at least slightly—their research focus, to encompass distinct-but-related technology opportunities, or (b) seek to acquire such research (or patents) from external sources. This in turn suggests that one effect of patent portfolios is to encourage the consolidation of distinct-but-related technologies and associated patents under a single firm's control.

forts. That is, the diverse nature of a patent portfolio means that researchers can freely move into distinct-but-related fields of inquiry with the assurance that patent protection is available; given the diversity of protection provided by a portfolio, such associated research can be conducted with less fear of infringement and a greater expectation of exclusivity. Thus, the semiconductor researchers posited above can more freely engage in research beyond the narrow focus of the particular project at hand, perhaps investigating the use of the new materials in other applications—with possibly important benefits accruing to the firm.[128]

c. *Addresses Uncertainty Related to Future Market Conditions*

Technology, of course, is not the only uncertainty in the innovation-driven marketplace. The vagaries of future market conditions—for example, the availability and costs of materials—can at least in part be addressed by holding a diverse patent portfolio.

d. *Addresses Uncertainty Related to Future Competitors*

Holding a patent portfolio can also hedge against future moves by one's competitors in the marketplace. The diversity-features of patent portfolios mean that the firm's future innovation path will be broader in potential (as described above) and thus less susceptible to interference from competitors' patent-related and market-related moves. For example, if a firm at time *t=0* has a significant market and/or innovation advantage, the construction of a substantial patent portfolio focused on that advantage will provide an enduring (albeit not permanent) hedge against the movement of existing competitors or the emergence of new challengers. Again, the diversity-features of the portfolio structure mean that such a hedge will be more resilient to uncertainty than would be possible in the individual patent context.

e. *Addresses Uncertainty in the Patent Law*

Perhaps most significantly, the diversity-features of patent portfolios offer a hedge against uncertainty related to the patent law itself. That is, because no single individual patent conclusively determines the value of a portfolio, any uncertainty in the law that could alter the value of individual patents will have less impact. The patent law has

[128] Take, for example, the 3M case example, where researchers are encouraged to inquire beyond their narrow, assigned research projects. *See, e.g.*, Thomas A. Stewart, *3M Fights Back*, FORTUNE, Feb. 5, 1996 at 94 ("One of 3M's crazy-like-a-fox traits is famous—the '15% rule' that tells researchers to spend that much of their time working on something other than their primary project.").

undergone significant transition in recent decades, and while some of these shifts have arguably resulted in greater certainty,[129] there are key areas of expanding uncertainty. For example, statistical studies show that the determination of claim construction issues—crucial for both validity and scope inquiries—is highly variable, and dependent upon the identity of judges hearing the case.[130] The Federal Circuit has also been engaging in a decade-long project to curtail (or at least define) the impact of the doctrine of equivalents, resulting in uncertainty concerning the future viability of that regime in expanding the scope of valid patents. The rise of a newly developed "written description" requirement casts doubt on the validity of many patents, especially those in areas of rapidly developing or uncertain technology.[131] This (arguably growing) level of uncertainty related to the validity and scope of patents only increases the relative benefits of patent portfolios because the value of a portfolio is not tied directly to a single patent (or to a small number of patents), and because many of these uncertainties turn on very fact-specific details of the individual patents

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[129] The most notable shift has been the creation of the United States Court of Appeals for the Federal Circuit. Perhaps the seminal work considering its formation and theoretical basis is Rochelle Cooper Dreyfuss, *The Federal Circuit: A Case Study in Specialized Courts*, 64 N.Y.U. L. REV. 1 (1989); *see also* Christian A. Chu, *Empirical Analysis of the Federal Circuit's Claim Construction Trends*, 16 BERKELEY TECH. L.J. 1075, 1078-79 (2001) (suggesting that the Federal Circuit has failed to achieve greater predictability in patent litigation); John F. Duffy, *On Improving the Legal Process of Claim Interpretation: Administrative Alternatives*, 2 WASH. U. J.L. & POL'Y 109, 111 (2000) (considering future innovations in claim interpretation that might solve procedural inefficiencies inherent in the current system of consolidated Federal Circuit review of patent appeals); Lemley, *supra* note 3, at 1496 (asserting that a more intensive patent evaluation process is unwarranted); Craig Allen Nard, *Process Considerations in the Age of* Markman *and Mantras*, 2001 U. ILL. L. REV. 355, 357 (2001) (calling for the Federal Circuit to accept interlocutory appeals of district court claim interpretations in order to promote certainty); Craig Allen Nard, *A Theory of Claim Interpretation*, 14 HARV. J.L. & TECH. 1, 82 (2000) (contending that the Federal Circuit uses a theory of claim construction called "hypertextualism" and concluding that the use of this theory is responsible for the court's failure to achieve certainty and coherence in its jurisprudence); Arti K. Rai, *Engaging Facts and Policy: A Multi-Institutional Approach to Patent System Reform*, 103 COLUM. L. REV. 1035, 1040 (2003) (arguing that the Federal Circuit has arrogated power over fact finding to the detriment of the patent system); Arti Kaur Rai, *Regulating Scientific Research: Intellectual Property Rights and the Norms of Science*, 94 NW. U. L. REV. 77, 79 (1999) (asserting that legal change has been out of step with the "instrumental goals of intellectual property").

[130] *See* R. Polk Wagner & Lee Petherbridge, *Is the Federal Circuit Succeeding? An Empirical Assessment of Judicial Performance*, 152 U. PA. L. REV. 1105, 1163-70 (2004) (demonstrating that different judges may come to dramatically different conclusions on claim construction issues).

[131] *See, e.g.*, Harris A. Pitlick, *The Mutation on the Description Requirement Gene*, 80 J. PAT. & TRADEMARK OFF. SOC'Y 209, 222 (1998) (noting that in light of recent decisions, numerous "patents on pioneering inventions are in danger of being held invalid").

involved (or even on the judges deciding the case), the portfolio holder can be more assured of the existence of a field of protection than would otherwise be possible.

3. An Inherent Tension: Scale Versus Diversity

One important insight into the dual-form benefits of patent portfolios (scale and diversity) is that substantial tension exists between these two goals. That is, as noted above, effective patent portfolios are both *sizable*—covering an expanse of closely related subject matter—and *diverse*—composed of distinct individual patents, thus diminishing the importance of any specific patentable subject matter. Yet maximizing one dimension will degrade the other. For example, increasing the size of a portfolio entails obtaining additional closely related patents (ideally, patents whose subject matter abuts existing holdings, so as to create a relatively seamless "super-patent"), but increasing the diversity of a portfolio is best achieved by obtaining additional patents with more distinct subject matters. A maximally diverse patent portfolio would be composed of individual patents that are virtually unrelated (and thus, in our definition, would fail to be a portfolio altogether). But such an atomized portfolio would be relatively ineffective in size-terms because of the significant gaps in subject matter coverage between constituent patents, creating what might be called a "swiss cheese effect." These holes in protection would result in far less confidence, for example, about the actual scope of enforceable coverage than would be the case where the subject matter of the individual patents was roughly coterminous. Further, an overly atomized patent portfolio would also provide significant openings for other firms to engage in similar (competing) research and development, and even to procure closely related patents themselves, thus greatly diminishing the value of the portfolio.

Similarly, the maximization of a portfolio's scale-effects will have negative consequences for diversity. That is, such a patent portfolio would be constructed for maximum density, with constituent patents covering small portions of directly coterminous subject matter. But this close relationship between individual patents—a benefit for scale-features—undermines the diversity of the portfolio (which derives from the differences between the individual patents), and thus diminishes the importance of diversity related benefits.

This observation—the tension between scale and diversity—suggests that effective patent portfolios will be carefully crafted affairs, where patenting decisions are made in light of these twin goals. This in turn suggests that patent portfolio construction is unquestionably a skill-oriented task, one that some firms will perform better (and perhaps far better) than others. Indeed, the dramatic benefits of well-

constructed patent portfolios mean that there is almost certainly a market value in such activities, a fact which is borne out by the recent emergence of firms dedicated to patent portfolio construction.[132]

C. *Paradox, Resolved: The Value of Quantity*

The tension between scale and diversity, however, does have an obvious solution: more constituent patents. As the number of individual patents involved in a portfolio increases, the structure becomes *both* more sizeable (covering a broader array of subject matter) and more diverse (covering a greater difference of subject matters). Similarly, the challenges inherent in portfolio construction identified above—the appropriate strategic focus between size and diversity—diminish as the number of obtainable patents increases. In this sense, high-volume patenting behavior is itself a way to diminish the importance of individual patenting decisions, because simply adding total patents to the portfolio will increase both its scale and diversity. Put simply, in a portfolio-driven era of patenting, high-volume patenting is the overwhelmingly dominant decision.

Thus the explanatory power of the patent portfolio theory in the modern patenting environment becomes clear: firms patent heavily to maximize the benefits of patent portfolios, and such benefits are directly determined by the quantity of patents assembled. In other words, the marginal value of increasing the size and diversity of the patent portfolio is substantially greater than the marginal value of the individual patent itself. Thus, obtaining the patent is advantageous even if the value of the individual patent is less than its acquisition cost. Indeed, under this theory, patenting decisions are essentially unrelated to the value of the individual patent. Instead, the question is whether the additional marginal value of adding the patent to the portfolio is greater than the acquisition cost.

This last point exposes another facet of the portfolio theory: the benefits of quantity, while substantial, are not unlimited. At some point there will be diminishing returns from adding patents to a portfolio, as the marginal value of the addition of more patents is outweighed by the acquisition cost. The insight of the patent portfolio theory, of course, is the recognition that this inflection point will occur at a quantity of patents far beyond that which can be explained by the marginal value of the patents themselves.

It is important to understand that the patent portfolio theory does not suggest that there are no limits to the value of portfolios or the

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[132] *See, e.g.*, Eric W. Pfeiffer, *Mine Games: Companies Are Coining Intellectual Property*, FORBES, June 24, 2002, at 60, 61-62 (discussing firms such as ThinkFire and ipValue that specialize in the exploitation of patent portfolios).

desirable quantity of patents. As the benefits noted above are maximized—for example, where an enduring, long-term market position is established, or a very broad range of possible innovation paths are protected—the marginal value of increasing the benefits will ultimately fall below the costs. Note, however, that the value-limits of a patent portfolio have little or no relationship to the value of the underlying patents, again confirming the intuition that modern patenting decisions are and should be independent of the value of the patents themselves.

III. PATENT PORTFOLIOS IN ACTION: CASE STUDIES

In this Part, we will demonstrate that a portfolio approach to understanding the value of patents is not merely a theoretic nicety, but rather the dominant approach to patenting in the real world. In particular, we will present three case studies that illustrate how companies employ the portfolio theory to gain and preserve a dominant position in their respective industries. It bears emphasis that the examples we use here are highly representative. There is ample evidence that the desire to achieve a strong patent portfolio shapes the patenting activities of virtually all innovating firms.

A. *Dominating a Technology via a Patent Portfolio: The Case of Qualcomm*

Qualcomm rose to prominence in the mid-1990s as part of the wave of technology firms that capitalized on the value of their patent portfolios by aggressively pursuing licensing agreements.[133] The leap to superstardom, however, did not occur until 1999, when the company began spinning off divisions in order to focus squarely on its intellectual property portfolio, and saw its stock soar over 2000% (noteworthy even amidst the flurry of speculation driving the dot-com bubble).[134] Despite suffering through the subsequent market downturn, the company has experienced significant growth over the past

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[133] *See, e.g.*, Mark Voorhees, *Ethereal Asset*, AM. LAW., May 2004, at 118, 119 (noting that in the 1990s, Qualcomm "started fattening [its] bottom line from licensing"). Some experts have estimated that in the 1990s, patent licensing revenue grew from $15 billion to over $100 billion per year. *See, e.g.*, RIVETTE & KLINE, *supra* note 1, at 5 (describing the general increase in licensing revenue from 1990 to 1998).

[134] *See, e.g.*, Simon Romero, *Qualcomm's Shrinking Act Could Pay Off Big: Company Prospers by Shedding Divisions and Focusing Fiercely on Patents*, N.Y. TIMES, Oct. 23, 2000, at C1 (discussing Qualcomm's dramatic increase in market capitalization); Gregory Zuckerman & Terzah Ewing, *Stocks Retreat a Little After Big Day, Decade*, WALL ST. J., Dec. 31, 1999, at C1 (same).

three years, including a $200 million increase in revenue from its licensing division.[135]

This meteoric success can be traced back to 1989, when the four-year-old startup introduced "code division multiple access" (CDMA) wireless technology as a better alternative to the "time division multiple access" (TDMA) digital system which had just been endorsed by the Cellular Telecommunications Industry Association (CTIA) after a two-year dispute over the industry standards.[136] Despite the network externalities which created a substantial barrier to entry into the wireless market at that time,[137] CDMA eventually supplanted TDMA, largely by virtue of being a superior technology.[138]

Qualcomm's insight was not simply in championing CDMA, but in anticipating future developments and aggressively pursuing an array of patents covering diverse applications of the standard.[139] The benefits to Qualcomm of this approach are two-fold: the company gener-

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[135] *See* QUALCOMM, INC., 2003 ANNUAL REPORT 41 (2003), *available at* http://www.qualcomm.com/ir/annualreport/QCOM_AR2003.pdf (reporting $1 billion in technology licensing revenues for fiscal 2003); QUALCOMM, INC., 2002 ANNUAL REPORT 47 (2002), *available at* http://www.qualcomm.com/ir/annualreport/QCOM_AR2002.pdf (reporting $836 million in licensing revenues for fiscal 2002 and $772 million for fiscal 2001). Recently, *Business 2.0* ranked the company thirtieth on its list of fastest-growing technology firms. *B2 100: Fastest-Growing Tech Companies*, BUSINESS 2.0, June 2004, at 115, 117.

[136] Dean Takahashi, *PacTel Cellular Takes a Gamble on Technology*, L.A. TIMES, Aug. 26, 1990, at D1.

[137] *See, e.g.*, Nee, *supra* note 99, at 213 ("In early 1989, when [Qualcomm CEO Dr. Irwin Jacobs] first approached wireless carriers to pitch CDMA, no Las Vegas bookie would have given Qualcomm any odds of success. AT&T, Motorola, and others had already opted for the so-called TDMA (time division multiple access) digital standard."). Five years later, numerous industry experts still predicted that Qualcomm would be unable to overcome its competitive disadvantage. *See, e.g.*, Susan Pulliam, *Qualcomm's Digital Technology Wins Praise, but Marketing Delays Are Raising Questions*, WALL ST. J., Oct. 11, 1994, at C2 (quoting an analyst as saying, "[i]t's too late for Qualcomm, at least in this round of technological change").

[138] *See, e.g.*, Alex Berenson, *Modem Company Growing In a Competitive Market*, N.Y. TIMES, Apr. 13, 2000, at C6 ("Most analysts agree that CDMA offers better performance than TDMA."); Justine Lau, *Operators Reject New 3G License*, FIN. TIMES, Mar. 26, 2004, at 27 ("CDMA is a widely used US network standard while TDMA is a less common standard used in mobile telephony.").

[139] Currently, the company has over 3000 patents and patent applications covering CDMA and related wireless technologies. 2003 ANNUAL REPORT, *supra* note 135, at 3.

ates a dual revenue stream[140] and prevents competitors from entering any aspect of the CDMA market.[141]

Qualcomm's official statements (in annual reports, press releases, and presentations to both investors and the media) make it clear that the company views the portfolio, rather than the individual patent, as the relevant level of abstraction for managing intellectual property assets.[142] Filings with the SEC further reflect a recognition of the portfolio as a distinct commodity.[143] Finally, the company consistently emphasizes the growing number of patents for which it applies and receives each year, as well as the broad applicability of the portfolio as a whole to a wide range of wireless technologies.[144]

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[140] In addition to income derived from its own products and services, the company receives upfront fees from licensing partners as well as ongoing royalty payments based on the sales of equipment incorporating Qualcomm technology. *Id.* at 34.

[141] *See, e.g.*, Nee, *supra* note 99, at 220 (stating that Qualcomm's patents "make up a portfolio so broad and deep that [according to general counsel Steven Altman] 'you can't deploy a CDMA product without infringing' . . . .").

[142] *See, e.g.*, 2003 ANNUAL REPORT, *supra* note 135, at 3 ("QUALCOMM's extensive patent portfolio has been recognized as essential to existing and proposed international CDMA standards . . . ."); Qualcomm, Inc., Q1 2004 Earnings Conference Call (Jan. 21, 2004), *available at* WESTLAW 1/21/04 FINDISCLOSURE 17:30:00 ("Qualcomm's license agreements with essentially all of the world's leading wireless equipment manufacturers have created a well established market value for our patent portfolio . . . ."); Press Release, Qualcomm, Inc., QUALCOMM and Alcatel Enter into a CDMA Infrastructure Patent License Agreement (July 16, 2002), *available at* http://www.qualcomm.com/press/releases/2002/press1062.html (announcing a licensing agreement that "further validates the strength of QUALCOMM's patent portfolio"); Press Release, Qualcomm, Inc., QUALCOMM Wins Three More Patent Oppositions in Korea and Europe (Jan. 23, 2001), *available at* http://www.qualcomm.com/press/releases/2001/press137.html (quoting Qualcomm's chief patent strategist as saying that individual patents being upheld demonstrates "the strength and necessity of QUALCOMM's CDMA patent portfolio"); Presentation, Qualcomm, Inc., Friedman Billings Ramsey 8th Annual Growth Investor Conference, Slide 13 (June 3, 2004), *available at* http://www.qualcomm.com/ir/ppt/pj_fbr060304.pdf ("QUALCOMM's Unique Patent Position: Patent Portfolio is a Strong Asset.").

[143] *See, e.g.*, Qualcomm Inc., Annual Report (Form 10-K), at 28 (Sept. 28, 2003), *available at* http://ccbn.10kwizard.com/download.php?type=PDF&ipage=2408390&cik=804328 ("We rely primarily on patent, copyright, trademark and trade secret laws, as well as nondisclosure and confidentiality agreements and other methods, to protect our proprietary information, technologies and processes, including our patent portfolio.").

[144] *See, e.g.*, Dr. Irwin Mark Jacobs & Anthony S. Thornley, Letter to Stockholders, *in* QUALCOMM, INC., 2003 ANNUAL REPORT, *supra* note 135, at 26 (claiming that Qualcomm's success "is derived in part from the strength of our ever-growing patent portfolio. More than 125 manufacturers have license agreements with QUALCOMM Technology Licensing (QTL) covering cdmaOne and CDMA2000 applications, and more than 50 manufacturers have licenses covering WCDMA and TD-SCDMA standards."); Press Release, Qualcomm, Inc., United States Patent Office Reaffirms the Validity of Important QUALCOMM CDMA Patent (March 23, 1999)), *available at* http://www.qualcomm.com/press/releases/1999/press458.html ("[N]o single patent

Table 3: Qualcomm's Yearly and Cumulative U.S. Patents[145]

	Issued	**Total**
Jan. 1999	245	815
Jan. 2000	388	1264
Jan. 2001	531	1582
Sept. 2002	888	2451
Sept. 2003	n/a	Over 3000

B. *Building Scale and Diversity: The Case of IBM*

When it comes to numbers, nobody beats Big Blue.[146] Since 1994, IBM has amassed over 25,000 U.S. patents, far more than any other company, each year ranking first on the USPTO's list of top patent earners.[147] Its closest competitor in that regard, Canon Kabushiki Kai-

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is critical to QUALCOMM's coverage of second or third generation CDMA wireless standards because QUALCOMM holds dozens of patents that are essential to the leading standards . . . .").

[145] 2002 ANNUAL REPORT, *supra* note 135; 2003 ANNUAL REPORT, *supra* note 135.

[146] At least one intellectual property lawyer has suggested that "IBM is perhaps the most formidable IP litigation opponent imaginable, not least because of its thermonuclear patent portfolio." Clegg Ivey, *Open Season on Open Source*, 51 LA. B.J. 440, 441 (2004). Currently, the company focuses its portfolio-building efforts in six relatively broad areas: microelectronics, server technologies, storage systems, network and e-business computing, display and printer technologies, and software. IBM, State-of-the-Art Patent Portfolio, http://www.ibm.com/ibm/licensing/patents/portfolio.shtml [hereinafter IBM, State-of-the-Art].

[147] Press Release, USPTO, USPTO Releases Annual List of Top 10 Organizations Receiving Most U.S. Patents (Jan. 11, 2005), http://www.uspto.gov/web/offices/com/speeches/05-03.htm; Press Release, USPTO, USPTO Releases Annual List of Top 10 Organizations Receiving Most U.S. Patents (Jan. 12, 2004), http://www.uspto.gov/web/offices/com/speeches/04-01.htm; Press Release, USPTO, USPTO Releases Annual List of Top 10 Organizations Receiving Most U.S. Patents (Jan. 13, 2003), http://www.uspto.gov/web/offices/com/speeches/03-01.htm; Press Release, USPTO, USPTO Releases Annual List of 10 Organizations Receiving Most Patents (Jan. 10, 2002), http://www.uspto.gov/web/offices/com/speeches/02-01.htm; Press Release, USPTO, USPTO Releases Annual List of Top 10 Organizations Receiving Most U.S. Patents (Jan. 10, 2001), http://www.uspto.gov/web/offices/com/speeches/01-02.htm; Press Release, USPTO, IBM Repeats at Top of PTO's Annual List of 10 Organizations Receiving Most Patents (Jan. 11, 2000), http://www.uspto.gov/web/offices/com/speeches/00-03.htm; Press Release, USPTO, IBM Repeats at Top of PTO's Annual List of 10 Organizations Receiving Most Patents (Jan. 8, 1999), http://www.uspto.gov/web/offices/com/speeches/99-1.htm; Press Release, USPTO, USPTO Announces Top Patent Earners (Jan. 12, 1998), http://www.uspto.gov/web/offices/com/speeches/98-01.htm; Press Release, USPTO, USPTO Announces Last Year's Top Patent Earners:

sha, received almost ten thousand fewer patents during the same period.[148] Moreover, the number of ideas being patented each year is on the rise—several times in the past decade, IBM set new records for the most U.S. patents received by an organization in a single year.[149]

In the 1980s, IBM struggled as the national consciousness came to associate excellence in technology with foreign-produced goods.[150] Moreover, the once-progressive company grew stagnant, falling from its perch as the leader in innovation.[151] But even then, IBM recognized the bargaining value of a robust portfolio,[152] as well as the leverage such a portfolio could provide when seeking to compel licensing agreements from potential infringers (perhaps unscrupulously).[153] Still, after a decade of very public management snafus, analysts and economists were writing the company's obituary.[154]

The turn-around began with the arrival of Lou Gerstner as CEO in 1993, appointed to replace John Akers after the company suffered its worst year ever.[155] Among the changes instituted under Gerstner's watch: substantially increasing efforts to exploit the company's intellectual property assets,[156] mandating a narrower focus on less theoreti-

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IBM Again Tops the List (Jan. 27, 1997), http://www.uspto.gov/web/offices/com/speeches/97-02.txt; Press Release, USPTO, IBM Leads List of Top 11 Patent Recipients for 1995 (Jan. 30, 1996), http://www.uspto.gov/web/offices/com/speeches/96-03.txt.

[148] *See* press releases cited *supra* note 147.

[149] *See* press releases cited *supra* note 147.

[150] *See, e.g.*, BACK TO THE FUTURE (Universal Studios 1985) (Doc: "No wonder this circuit failed – it says 'Made in Japan.'"; Marty: "What do you mean, Doc? All the best stuff is made in Japan.").

[151] *See, e.g.*, JAMES C. COLLINS & JERRY I. PORRAS, BUILT TO LAST 224 (1994) ("IBM got conservative in the 1980s, protecting its mainframe line. It lost sight of its own past.").

[152] Bob Davis, *Computer Firms Turn to Patents, Once Viewed as Weak Protection*, WALL ST. J., Jan. 28, 1986, at 33, 33 (quoting an attorney for IBM as saying "[h]aving a patent portfolio is important to obtaining access to other people's patents").

[153] Gary L. Reback, *Patently Absurd*, FORBES, June 24, 2002, at 44, 45-46 (quoting a lawyer for IBM as saying "maybe you don't infringe these seven patents. But we have 10,000 U.S. patents. Do you really want us to go back to Armonk [IBM headquarters in New York] and find seven patents you do infringe? Or do you want to make this easy and just pay us $20 million?") (brackets in original). *But see* Jonathan Krim, *Patenting Air or Protecting Property? Information Age Invents a New Problem*, WASH. POST., Dec. 11, 2003, at E1 ("Jerry Rosenthal, IBM's vice president of intellectual property, denied that the incident occurred the way Reback described.").

[154] *See, e.g.*, CHARLES H. FERGUSON & CHARLES R. MORRIS, COMPUTER WARS: HOW THE WEST CAN WIN IN A POST-IBM WORLD xii (1993) ("[T]here is a serious possibility that IBM is finished as a force in the industry.").

[155] *See, e.g.*, Patricia Sellers & David Kirkpatrick, *Can This Man Save IBM?*, FORTUNE, Apr. 19, 1993, at 63, 63 ("Gerstner [replaced] CEO John Akers in January after the company's worst year ever.").

[156] *See, e.g.*, Kline, *supra* note 99, at 58 (describing a $650 million increase in yearly patent licensing revenue, due to "better use of [IBM's] patent portfolio").

cal and more product-oriented research,[157] and slashing the R&D budget[158] while simultaneously initiating a campaign to increase the number of patents the company received.[159] This led not only to the remarkable growth of the company's patent portfolio, but also to a significantly reduced ratio of research dollars spent to patents earned. Even taking into account the approximately twenty-eight months required for the average patent prosecution,[160] patent intensity—patents obtained per R&D dollar—at IBM has exploded.[161]

[157] *See, e.g.*, Raju Narisetti, *IBM Wins 1,724 Patents for No. 1 Spot On '97 List, but Fruits of R&D Fall 8%*, WALL ST. J., Jan. 12, 1998, at B16 ("Some observers have wondered if IBM's cuts and its narrower focus on product-oriented research would prompt its scientists to avoid long-shot projects that nevertheless might yield a home run.").

[158] *See, e.g.*, Robert Buderi, *Into the Big Blue Yonder*, TECH. REV., July/Aug. 1999, at 46, 48 ("Gerstner slash[ed] nearly $2 billion from IBM's $5.1 billion annual R&D budget.").

[159] Louise Kehoe, *International Company News: IBM Heads List for US Patents*, FIN. TIMES, Jan. 13, 1994, at 29.

[160] *See, e.g.*, Mark A. Lemley, *An Empirical Study of the Twenty-Year Patent Term*, 22 AIPLA Q.J. 369, 385 (1994) (determining that the mean prosecution time is 864 days).

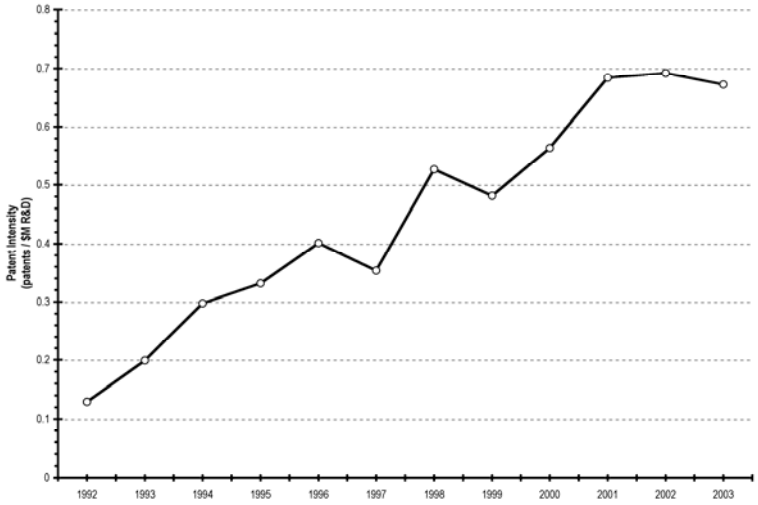
[161] *See* Figure 3 (demonstrating a nearly six-fold rise in patent intensity (patents per million dollars of R&D budget) during the decade 1992-2003.). The following table presents the raw data:

	1992	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Patents	842	1,107	1,298	1,383	1,867	1,724	2,657	2,756	2,866	3,411	3,288	3,415
R&D*	6,522	5,558	4,363	4,170	4,654	4,877	5,046	5,723	5,084	4,986	4,750	5,077

** dollars in millions.*

IBM Annual Reports, 1994-2003.

Figure 3: Shifting to a Portfolio Strategy: IBM's Exploding Patent Intensity[162]



By some measures, IBM's portfolio-building success has come at the price of its patent quality: although the undisputed leader based on sheer numbers, the company lags behind peers such as Microsoft, Cisco, and Sun Microsystems on indexes that measure how often a company's patents are cited as prior art and how close its portfolio is to the cutting edge of research.[163] Nevertheless, IBM's dramatic overhaul paid off: the portfolio provides the company's engineers with the freedom to experiment unhindered by concerns of infringing on others' patents,[164] and IBM has turned intellectual property licensing into a "fine art"[165] that has generated over $10 billion in the last decade.[166] Indeed, the licensing division has become so profitable and

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[162] *See supra* note 161.

[163] *See, e.g.*, Evan I. Schwartz, *Patents Go Global*, TECH. REV., May 2003, at 55, 60 (explaining that because of IBM's extensive patent portfolio, "IBM engineers [are able to] simply design the best product possible without worrying about patent concerns.").

[164] *See, e.g.*, Julie Moran Alterio, *Taking the Measure of Patents*, J. NEWS, Apr. 1, 2003, at 1D ("IBM engineers simply design the best product possible without worrying about patent concerns, said Jerry Rosenthal, vice president for property and licensing at IBM.").

[165] *More Rembrandts in the Attic*, ECONOMIST, Jan. 19, 2002, at 53.

[166] John Teresko, *IBM's Patent/Licensing Connection*, INDUSTRY WEEK, Mar. 2003, at 16; IBM, 2003 ANNUAL REPORT (2003). Annual licensing revenue grew from approximately $350 million in 1993 to slightly over $1 billion in 2003, with a high-water mark in 1999 and 2000, when the licensing revenue was over $1.5 billion each year. Narisetti, *supra* note 157, at B16; IBM, ANNUAL REPORTS 2000-2003, *available at* http://www.ibm.com/annualreport/.

efficient that IBM now consults with other firms on how to maximize income from their own patent portfolios.[167]

C. *Assembling a Patent Portfolio from Alternative Sources: The Case of Gemstar*

Henry Yuen launched Gemstar in 1989 with a simple dream: to help the nation program its VCRs.[168] He (along with partner David Kwoh) developed an algorithm for converting information about a TV show into a short string of numbers; convinced newspapers and TV Guide to carry the codes in their listings; and designed a set-top box to convert those codes back into instructions telling the device the date, time, and channel of the program the end-user wanted to record.[169] Gemstar's device, the VCR Plus+, was an immediate success, and Yuen raked in millions.[170]

As the company grew, it sought to apply its patented technology to related emerging fields. Yuen's vision was for Gemstar to assemble a portfolio of patents which could be used to claim coverage over all aspects of on-screen guides and interactive program listings.[171] Although the company conducted some research and development in-house, Gemstar's primary method of expansion was to acquire smaller companies with potentially valuable patents,[172] and to use the threat of expensive infringement litigation to force competitors either into licensing deals or out of the field.[173]

Gemstar soared through the 1990s with a string of high-profile successes, most notably the acquisition of TV Guide (which resolved a

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[167] Teresko, *supra* note 166, at 16.

[168] *See* David Churbuck, *Success Formula*, FORBES, May 27, 1991, at 334 (recounting the genesis and early success of Gemstar). The firm was originally founded in 1986 as a real-estate holding company. Walter Hamilton & Karen Kaplan, *Can Gemstar Keep Rising?*, L.A. TIMES, Aug. 9, 1998, at D1.

[169] Churbuck, *supra* note 168, at 334.

[170] *Id.*

[171] *See* Hamilton & Kaplan, *supra* note 168, at D1 (analyzing Gemstar's then-imminent entry into the interactive program listings market).

[172] *See, e.g.*, Stacy Kravetz, *Gemstar to Buy Rival StarSight in a Stock Swap*, WALL ST. J., Dec. 26, 1996, at 11 (detailing Gemstar's acquisition of StarSight, a rival with valuable interactive television program guide patents).

[173] *See, e.g.*, Jonathan Fahey, *Screen Grab*, FORBES, Mar. 5, 2001, at 52, 52 ("[Gemstar's Henry Yuen] forced or coaxed giants Microsoft, Motorola and AOL into licensing deals, using his array of patents as weapons."); Anne Colden, *EchoStar Countersues Gemstar*, DENVER POST, Dec. 6, 2000, at C2 (quoting EchoStar's antitrust complaint as alleging "Gemstar wields its patent portfolio, which it claims covers any IPG product on the market, to coerce companies into license agreements containing numerous anti-competitive terms").

long-standing patent dispute).[174] But Yuen's aggressive strategy prompted an industry backlash,[175] and a series of courtroom defeats led competitors and licensees to question the strength of Gemstar's patent portfolio.[176] Yuen was finally ousted in 2002 following revelations that the company was overstating revenue.[177]

Today, Gemstar still maintains a portfolio of over 260 patents on listing and interactive technologies,[178] and numerous analysts believe the size of this portfolio, combined with a less combative attitude towards licensees, leaves the company poised for a long-term dominant role in the industry.[179]

IV. THE IMPLICATIONS OF PATENT PORTFOLIOS

A. *The Explanatory Power of the Portfolio Theory*

As we argued above, the patent portfolio theory has profound implications for the way we understand the modern patent system. By recognizing that the true value of patents inheres not in their individual worth, but in their status as components of strategically developed portfolios, this theory allows for a far richer (and a more empirically accurate) view of what drives current patenting behavior.

Accordingly, a major prescriptive message that emanates from this paper is straightforward: research and scholarship that examines the patent system must do so in the context of patent portfolios. The era of individual patents is over; gone are the days when the incentives,

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[174] John Lippman, *Gemstar, TV Guide Close Merger After Regulatory Delay*, WALL ST. J., July 13, 2000, at C14. Following the merger, the company changed its name to Gemstar-TV Guide International Inc. *Id.*

[175] *See* Fahey, *supra* note 173, at 52 ("[A] cadre of four of its biggest cable customers, sick of Gemstar's near-monopoly, have developed a competing interactive guide that was painstakingly designed to avoid infringing Gemstar's patent portfolio."); Martin Peers, *Hit or a Bad Rerun for Gemstar?*, WALL ST. J., Apr. 13, 2004, at C1 (discussing how Yuen's "aggressive tactic alienated companies he needed to deal with").

[176] *See, e.g.*, Erin Joyce, *Gemstar Patent Woes Signal Shift in iTV Tech*, ATNEWYORK.COM, June 25, 2002, http://www.atnewyork.com/news/article.php/1371211 (quoting an analyst as saying Gemstar's "mystique has been broken"); George Mannes, *Falling Gemstar Can't Catch a Break*, THESTREET.COM, Sept. 3, 2002, http://www.thestreet.com/_tscs/tech/georgemannes/10040293.html (quoting an analyst as saying it seems "the threat of the patents was more powerful than the patents itself [sic]").

[177] Sallie Hofmeister, *Gemstar Agrees to $10-Million Settlement*, L.A. TIMES, June 24, 2004, at C1.

[178] GEMSTAR-TV GUIDE, 2003 ANNUAL REPORT 9, *available at* http://media.corporate-ir.net/media_files/irol/11/111956/reports/annual03.pdf.

[179] *See* Peers, *supra* note 175, at C1 (describing differing views on Gemstar's "comeback").

strategies, and cost-benefit calculations of patents could be evaluated in isolation. As we noted before, in the current patent system, the whole is greater than the sum of its parts—and modern patent scholarship must reflect that understanding.

This exhortation to utilize the patent portfolio theory is not merely due to theoretical considerations. As we noted above, the portfolio theory offers substantial explanatory power—and foreshadows a new generation of patent scholarship springing from its insights and empirical foundation. In particular, we note the following major explanatory and descriptive implications of the patent portfolio theory.

1. The Patent Paradox, Resolved

As we noted in Part I, substantial recent attention has been turned to the dissonance between traditionalist theories of patent value and the current high rate of patenting, a situation conventionally described as *the patent paradox*.[180] To recap, the patent paradox asks why, if patents have little expected value, do large firms expend so many resources to obtain so many patents?[181]

The portfolio theory, as we have developed it throughout this Article, answers that question directly and straightforwardly: firms patent heavily *not* to realize the value of individual patents, but to purchase the advantages of the aggregation of these individual patents into patent portfolios. The whole is greater than the sum of its parts: the benefits of patent portfolios in the modern innovation environment are, we suggest, so substantial as to explain the heretofore largely unexplained "value gap" at the heart of the patent paradox.[182]

Importantly, the patent portfolio theory established in this Article does not so much address the patent paradox as eliminate it. That is, once one reconsiders the modern patenting environment through the explanatory lens of the patent portfolio theory, the bases for the long-described patent paradox fall away. In the modern portfolio-focused patenting system, there is no real question why firms patent at rates higher than conventionally expected: they are simply behaving rationally, seeking patents whenever the marginal expected value of expanding the portfolio outweighs the marginal cost of obtaining that additional patent. That is, our analysis fully explains the high-volume

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[180] *See, e.g.*, Hall & Ziedonis, *supra* note 1, at 102 (explaining the patent paradox in the context of the semiconductor industry, where "the gap between the relative ineffectiveness of patents . . . and their widespread use is particularly striking"); *see also supra* Part I.A.

[181] *See supra* Part I.A (discussing the patent paradox).

[182] *See supra* Part II.B (detailing the benefits of patent portfolios).

of patenting despite the fact that the average value of individual patents is very low.

Indeed, one counterintuitive finding of the patent portfolio theory is that the link between patenting intensity and the average value of individual patents is not merely attenuated, but likely to be *inverse*: as the average expected value of patents declines, a portfolio strategy will increase in salience, in turn leading to even greater patenting intensity. In other words, because the true value of patents lies in their aggregation (in large numbers), firms seeking patent protection are increasingly forced to do so via a high-quantity, portfolio-focused patenting strategy. This in turn implies an ever higher overall patenting intensity, even as the average expected value of individual patents falls.

Accordingly, perhaps the primary implication of the patent portfolio theory developed in this Article is the recognition that the recent "paradoxical" trends in patenting behavior are in fact simply predictable responses to the observable circumstances. Indeed, the errant focus on individual patents led patent theorists astray, making them believe that the modern patent system was beset by an insoluble paradox. Once the analytic focus shifts to the portfolio level, the paradox suddenly ceases to exist. Collections of related patents generate considerable advantages for patentees—advantages that go well beyond the aggregated value of each individual patent. Rational firms will seek to achieve the benefits of patent portfolios—and thus increase their patent intensity. Paradox resolved. For patent scholars, researchers, and policymakers alike, this explanatory insight should yield far better understanding about the nature and function of the modern patenting system.

2. Explaining Patenting Patterns

Another important aspect of the explanatory power of the patent portfolio theory is its illumination of the drivers of modern patenting patterns among firms. In particular, we note that the portfolio theory fits nicely alongside the otherwise perplexing results of several recent empirical studies of patenting patterns.

a. *Large Firms Patent More, Small Firms Patent More Carefully*

Statistical studies of patenting patterns have shown that while the vast share of patents are obtained by large, incumbent firms—which may, in some cases, patent at higher rates—small firms are likely to

patent proportionally more important innovations.[183] This pattern poses something of a challenge to traditional theories, particularly the appropriability theory of patents.[184] That is, because small firms lack many of the advantages of larger, incumbent players, these firms should be even more aggressive in seeking patent protection.[185]

Under the patent portfolio theory, this pattern is both explainable and expected. In part this comes from recognizing the different pat-

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[183] On the relationship between firm size and quantity of patents, John Allison and Mark Lemley found that about 70% of issued patents were filed by large entities, while about 11% are filed by small businesses. John R. Allison & Mark A. Lemley, *Who's Patenting What? An Empirical Exploration of Patent Prosecution*, 53 VAND. L. REV. 2099, 2128 (2000).

The relationship between firm size and the *rates* of patenting (e.g., per R&D dollar) is more mixed. On the one hand, an empirical study of patenting among firms in the chemical industry found that a 1% increase in firm size leads to a 0.3% increase in the patent rate. Marvin B. Lieberman, *Patents, Learning by Doing, and Market Structure in the Chemical Processing Industries*, 5 INT'L J. INDUS. ORG. 257, 267 (1987). Furthermore, Ariel Pakes has demonstrated that a stronger relationship between the quantity of R&D investment and the propensity to patent exists, where a 1% increase in the R&D expenditures yields a 1.56% increase in patenting. Pakes, *supra* note 1, at 402. On the other hand, Wesley Cohen and Steven Klepper report the general feeling among economists that the rate of patenting among firms actually decreased with firm size—though they posit that such findings are at least partially reversed by evaluating the patent rate in terms of business unit rather than multi-product firms. Wesley M. Cohen & Steven Klepper, *A Reprise of Size and R&D*, 106 ECON. J. 925, 930-31 (1996).

On the relationship between firm size and "quality" or "importance" of the patents, see, for example, F.M. Scherer, *Schumpeter and Plausible Capitalism*, 30 J. ECON. LITERATURE 1416, 1423 (1992) (discussing opposing viewpoints on the nature of the connection between firm size and patent quality); CHI RESEARCH, INC., SMALL SERIAL INNOVATORS: THE SMALL FIRM CONTRIBUTION TO TECHNICAL CHANGE 11-12 (2003) (finding that small firms produce disproportionately high amounts of high-quality patents and innovation).

[184] As many in the economics literature have observed, these patterns—if you posit a relationship between real innovation and patenting rates—also challenge the Schumpeterian theory that large firms are more efficient and effective producers of innovation. *See* Cohen & Klepper, *supra* note 183, at 930 (analyzing differences in innovation between large and small firms); *see generally* JOSEPH A. SCHUMPETER, BUSINESS CYCLES: A THEORETICAL, HISTORICAL AND STATISTICAL ANALYSIS OF THE CAPITALIST PROCESS (1939) (comparing the advantages of large and small firms in technological innovation); JOSEPH A. SCHUMPETER, CAPITALISM, SOCIALISM, AND DEMOCRACY (3d ed. 1950) (describing large firms' advantages in innovation). Note that this might be at least partially explained by the patent portfolio theory as well. Once one relaxes the assumption that patent counts are a meaningful indicia of innovation (as opposed to a strategic goal exogenous to innovation) then it seems less surprising that large firms get less innovative bang for their patenting buck: a portfolio-focused patenting approach is, as we noted in Part II, only loosely related to innovation at all.

[185] *See* Jonathan M. Barnett, *Private Protection of Patentable Goods*, 25 CARDOZO L. REV. 1251, 1283 (2004) ("Aggressive litigation defense by small firms suggests that patents are of greater marginal value to these firms, especially considering the fact that litigation costs are more burdensome for a smaller firm with lower cash reserves and a weaker ability to raise external financing.").

enting strategies available to large and small firms in the modern portfolio-focused environment. For large firms, a major driver of patenting behavior is the need to create substantial patent portfolios—independent of the expected values of any particular individual patents. As we established in Part II.B, significant incentives operate to make a high quantity of patents within a technical field an overriding goal. Small firms, however, are likely to be substantially more resource constrained, and thus will simply not be able to play the portfolio game in any meaningful way.[186] This limitation will have two predictable effects: first, as we note below, it suggests that the modern patenting environment is adverse to small firms generally; and second, it implies that a firm that cannot engage in portfolio building is forced to revert to the (far) higher-risk strategy of selectively seeking "important" patents within a technical field. Because the information about which patents are commercially or technologically "important" is quite difficult to develop at an early stage of innovation, we view this approach as clearly dominated by the portfolio-directed strategy common among larger firms, though the facts seem to show that a selective strategy is not entirely unsuccessful.[187]

That large and small firms experience the portfolio theory in different ways suggests, of course, that a transition point exists, a level at which once-small firms begin to shift resources from a "high-quality" to a "large-scale" patenting approach. Indeed, it may well be that many small firms view their initial patenting efforts as merely building the foundation of future portfolio efforts.[188] And, as the benefits of patent portfolios become more widely understood, and potentially more pronounced, this transition point should move in the direction of smaller, less-resourced firms—an observed pattern that already exists, as we note immediately below.

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[186] We use the term "resource constrained" to primarily describe firms whose expectations of near-term resources for patenting are constrained; a firm that expects a dramatic increase in resources available for obtaining patents in the future would, we suggest, shift to a portfolio-building strategy for the reasons suggested in Part II.

[187] *See* Barnett, *supra* note 185, at 1288-89 (noting that small firms are responsible for a disproportionately high number of innovations). Indeed, in his recent work on the impact of patents in the software industry, Professor Ronald Mann concludes that "[t]he effects of patents are much more likely to benefit small firms and contribute to industry fragmentation than to benefit large firms and contribute to industry concentration." Ronald J. Mann, *Do Patents Facilitate Financing in the Software Industry?*, 83 TEX. L. REV. 961, 967-68 (2005).

[188] *See* Patel, *supra* note 116, at 1 (advocating that startup companies carefully build patent portfolios to accomplish "a variety of business objectives, such as bolstering market position, protecting R&D efforts, generating revenue, and encouraging favorable cross-licensing or settlement agreements"); Braunschweig, *supra* note 99, at 24 (noting the business goal of some young companies in the nanotechnology industries to build patent portfolios).

b. *An Increasing Share of Patents for Small Firms*

Throughout the 1990s, the share of all patents obtained by small firms and firms with relatively few prior patents increased, at the same time that the value of (individual) patents appears to have diminished.[189] This, we think, is explained by the growing salience of the patent portfolio theory: the "small firm" strategy we noted above (patenting relatively few, high-quality patents)[190] is increasingly outpaced by the large-firm portfolio-building approach. As the patent system moves further and further in the direction of our portfolio theory, the expected result is that ever smaller firms will adopt the dominant strategy of building collections of large numbers of related patents, irrespective of individual worth. In other words, as the patent system tilts to the advantage of large firms (i.e., those with large patent portfolios and the ability to build the same), successful small firms must engage the patent system as these large firms do.[191]

c. *Patterns of Patent Litigation*

The patent portfolio theory can also help illuminate the characteristics of patent litigation that have emerged in several important recent studies. For example, while the rate of patent litigation (measured on a per-patent basis) does not appear to be rising overall,[192] the rate of such litigation is rising among small firms and firms with smaller total patents.[193] In other words, observable trends in patent

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[189] *See* A PATENT SYSTEM FOR THE 21ST CENTURY, *supra* note 2, at 31 (acknowledging that small and new firms account for a larger share of patents). Note that because there was a concurrent increase in the amount of overall R&D conducted by both large and small firms, the trends related to patent intensity are unclear. *See id.* at 28-35 (describing the general surge in patent activity).

On the diminished expectations of patent value, see *supra* Part I.

[190] *See supra* note 188 and accompanying text.

[191] As we note in Part IV.C below, whether this new environment eliminates or even meaningfully reduces the advantages of large firms is doubtful.

[192] *See* Jean O. Lanjouw & Josh Lerner, *The Enforcement of Intellectual Property Rights: A Survey of the Empirical Literature*, 49/50 ANNALES D'ÉCONOMIE ET DE STATISTIQUE 223, 230 (1998) (stating that litigation rates were about 1% in the 1980s); Jean O. Lanjouw & Mark Schankerman, *Characteristics of Patent Litigation: A Window on Competition*, 32 RAND J. ECON. 129, 131 (2001) (reporting the average litigation rate to be 1%).

[193] *See* Lanjouw & Schankerman, *supra* note 192, at 147 (asserting that smaller firms are at a "high risk" of litigation); Jean O. Lanjouw & Mark Schankerman, *Enforcement of Patent Rights in the United States*, *in* PATENTS IN A KNOWLEDGE-BASED ECONOMY, *supra* note 1 [hereinafter Lanjouw & Schankerman, *Patent Rights*] (finding that individuals and small companies are "much more likely to be involved in suits"); Jean O. Lanjouw & Mark Schankerman, *Enforcing Intellectual Property Rights* 26 (Nat'l Bureau of Econ. Research, Working Paper No. 8656, 2001) ("[S]mall companies are much more likely to be involved in suits.").

litigation suggest that firms with large patent portfolios are significantly less likely to litigate than smaller firms.[194] This is, of course, an entirely expected result when you understand the patent system via patent portfolios: as we noted in Part II.B, a major advantage conferred upon portfolio holders is that litigation is less necessary to achieve marketplace ends.[195] By contrast, firms lacking effective patent portfolios will find themselves increasingly unable to reach beneficial accommodations with their more portfolio-rich competitors, and will be forced to the more costly, more prolonged, and higher risk strategy of patent litigation.[196]

B. *Through the Portfolio Prism: Understanding the Expanding Value of Patents*

In this Part, we revisit the patent theories we discussed in Part I and analyze how they should be recast in light of our portfolio approach. We show that the portfolio theory provides a comprehensive framework for understanding the modern patent system and hence has the ability to unify seemingly divergent contributions to the patent literature.

The portfolio approach has perhaps the farthest reaching implications for the "lottery" and "signaling" theories of patents. Hence, we consider these theories first. Recall that the lottery theory analogizes the inventive process to a giant lottery where patents are the equivalent of lottery tickets.[197] The lottery theory emphasizes the randomness that attends the inventive process and divides the universe of patents into a large set of "losers" (valueless patents) and a tiny set of "winners" (extremely valuable patents). The portfolio approach offers a very different view of the patent system. Our focus on aggregations of patents reveals that patents dramatically diverge from lotteries.

First, our analysis shows that careful planning of a patent portfolio can substantially enhance a firm's competitive position and positively affect its revenues. The portfolio theory proves that there are rhyme

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[194] *See* Lanjouw & Schankerman, *Enforcing Intellectual Property Rights*, *supra* note 193, at 20 (explaining that "having a larger portfolio of patents reduces the probability of being involved in a suit on any individual patent owned by the firm").

[195] Again, this precise point has empirical support: Lanjouw and Schankerman find that firms with portfolios that are large relative to a likely disputant's portfolio are significantly less likely to use the courts. Lanjouw & Schankerman, *Patent Rights*, *supra* note 193, at 148.

[196] Lanjouw and Schankerman also find that these smaller firms have no greater success rate in litigation, and thus face higher costs and greater delays in enforcing their (individual) patent rights, further confirming the portfolio theory's intuition that the patent system disadvantages smaller (or less portfolio-savvy) firms. *Id.* at 169-71.

[197] *See supra* Part I.B.3.

and reason to innovation—as opposed to pure randomness and chance. In order to outperform the competition, firms cannot simply pursue any patent that comes their way and hope to get lucky. Rather, firms must carefully plan their portfolio and pursue those patents that increase the overall value of their holdings.

Second, the portfolio theory suggests that the pursuit of patents by corporations is not strictly driven by risk-seeking and excess optimism on the part of corporate managers, as the lottery theory assumes. Through the portfolio prism, the decisions of corporate managers appear both rational and even risk-averse. The portfolio theory maintains that patents are not just lottery tickets that represent a small probability of winning a grand prize, but rather building blocks of commercial success. Hence, a corporate policy that encourages patenting may actually indicate managerial responsibility and careful planning.

Third, our analysis implies that patenting policies are not nearly as one-dimensional as the lottery theory suggests. Even patents that have no independent value can enhance the strength of a company's portfolio when combined with other patents. Furthermore, unlike lottery tickets, patents can exhibit superadditivity.[198] The value of a well-designed portfolio will always exceed the sum of the values of the individual patents. Thus, firms will seek to obtain a fairly wide range of patents, not just extremely valuable ones. More specifically, firms will prefer to patent whenever the marginal contribution of a patent to the portfolio exceeds the cost of obtaining it.

However, in other respects, the lottery theory and the portfolio theory are consistent and even reinforce one another. For example, similar to the lottery theory, the portfolio theory recognizes the importance of high-value patents. Such patents anchor portfolios and an ideal portfolio must include some high-value patents. Furthermore, the lottery theory and portfolio theory might be complementary in some cases. A firm's investment in R&D may be guided both by the desire to add marginal value to its portfolio and the hope for a windfall payoff.[199]

The portfolio theory has equally significant implications for the signaling theory.[200] First, the portfolio theory reinstates the view that

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[198] Superadditivity exists when $f(x+y) > f(x) + f(y)$.

[199] A more appropriate metaphor, therefore, may be something akin to a Wonka candy bar: worth the purchase price for the chocolate alone, but made even more desirable by the possibility of finding an elusive Golden Ticket. *See* ROALD DAHL, CHARLIE AND THE CHOCOLATE FACTORY 24 (1964) (describing that the five "Golden Tickets" had been hidden underneath ordinary wrapping paper of ordinary candy bars).

[200] *See supra* Part I.B.1.

the exclusivity conferred by patents is valuable; indeed, considerably more valuable than any signaling function patents perform. As we have demonstrated, patent portfolios can generate substantial economic rents for their holders and give patentees an important competitive advantage. Hence, the signaling theory captures only a secondary aspect of the role of patents.

Second, insofar as signaling is concerned, the portfolio theory implies that individual patents are not very useful signals. To get an accurate sense of a company's position within a certain industry, third parties must examine the company's patent portfolio as a whole. Most of the individual patents that comprise a portfolio will prove to be of very little value when analyzed in isolation. From a portfolio perspective, however, such patents may be quite valuable.

And yet, the signaling theory and the portfolio theory are not mutually exclusive. The portfolio theory accepts the premise that portfolios convey important information about firms. Long was certainly correct to point out that patent portfolios—or patent counts, as she sometimes calls them—are able to convey relevant information about corporations.[201] But in this regard, the portfolio theory offers two refinements to the signaling theory. First, our theory suggests that the most important signal a portfolio conveys to potential investors and third parties is that the firm understands the modern business environment and is competitive vis-à-vis other companies in the same industry. Second, our analysis suggests that when reviewing a patent portfolio, third parties cannot simply count the patents. Rather, they must consider the overall structure of the portfolio and pay close heed to the specific composition thereof. In deciphering a portfolio signal, it is critical to determine (1) whether the individual patents complement one another so as to generate a superadditive effect, and (2) how well the portfolio hedges against risk and uncertainty.[202]

As for the defensive patenting theory,[203] the portfolio theory complements it in two important ways. First, the portfolio theory demonstrates that patents serve a myriad of non-defensive purposes. Specifically, we have shown that patent portfolios facilitate in-house innovation, draw on related external inventions, enhance efforts to attract capital, and, in some cases, give voice in the politics of the patent system. Second, our analysis pours concrete content into the defensive patenting theory—in essence, by providing a theoretical blueprint for maximizing the defensive effects of patents. Our discussion in Part II elucidates how patents should be combined to effectively

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[201] Long, *supra* note 1, at 646.

[202] *See* discussion *supra* Part II.B.

[203] *See supra* Part I.B.4.

protect the patentee. To gain a strong defensive position, it is not enough to accumulate patents. The portfolio theory instructs that, on the one hand, the individual patents in a portfolio must be interrelated and concentrated in certain areas of research. On the other hand, however, the portfolio theory cautions against overconcentration of patents and generally advises patentees not to confine their patenting efforts to one line of research or a single technology.

Finally, the portfolio theory gives new meaning to the internal-metric theory.[204] As it stands, the internal-metric theory contends that individual patents may be used to measure the productivity of R&D employees. Although we maintain that this version only pertains to valuable individual patents, our analysis implies that patents may be used to measure the success rate of a research group as a whole. If the R&D division succeeds in creating and maintaining a viable patent portfolio, it means that the division is performing well overall. While individual patents are a problematic measure of individual productivity, viable portfolios provide an effective metric for assessing group performance.

C. *Predictive Insights*

Viewing the modern patent system through the portfolio lens also offers meaningful insights into future trends in the innovation environment. In this Part, we note a few predictions about the future of the modern patent system in light of the patent portfolio theory.

1. Patent Intensity Will Remain High

Perhaps the most important prediction enabled by the portfolio theory is that the current patent intensity (patents obtained per research dollar) should not be expected to drop dramatically—at least absent the intervention of other major factors, such as substantive legal changes. Given the advantages of patent portfolios,[205] we expect that modern, innovation-driven firms will increasingly view patent portfolios as essential to their long-term success, and behave accordingly. We expect that firms will continue to maximize the number of patents per R&D dollar.[206]

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[204] *See supra* Part II.B.2.

[205] *See supra* Part II.B.

[206] *See supra* Part II.C (discussing why firms will choose to seek a large quantity of patents).

2. Pressure on the PTO Will Increase

Lately there has been a growing concern with the quality of review of patent applications by the PTO. Scholars who have studied the PTO have pointed out that the poor review process is due, at least in part, to insufficient resources.[207] The PTO is both underfunded and understaffed. The recent increase in the number of filings has stretched the PTO to its limit, and perhaps beyond. On average, patent examiners spend only eighteen hours on each application they review. Furthermore, the reward structure of patent examiners gives them an incentive to approve the applications they review.[208]

The portfolio theory implies that, barring a major reform in the PTO, the quality of review will remain poor for the foreseeable future. Our analysis suggests that the number of filings will remain high. This means that the pressure on patent examiners is not going to ease and that the quality of review is unlikely to improve. True, patent examiners could, in theory, spend more time on each application. But, if the number of examiners is to remain constant, a more careful review process will worsen the backlog in the PTO. According to some reports, even at the current rate of review the wait time between filing and a decision may soon top five years.[209] Slowing down the review process in order to improve the quality will almost surely necessitate a much longer wait. More importantly, since approving applications increases the examiner's reward, it cannot be seriously expected that patent examiners will initiate a more exacting review of patent applications. Hence, without external intervention, the quality of the review process will not improve.[210]

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[207] *See, e.g.*, Merges, *supra* note 75, at 603-05 (noting the lack of adequate resources at the PTO and suggesting that the PTO use more of its time evaluating patents that have high potential future value).

[208] *See id.* at 609 ("The current bonus system is believed to skew incentives in favor of granting patents."); John R. Thomas, *Collusion and Collective Action in the Patent System: A Proposal for Patent Bounties*, 2001 U. ILL. L. REV. 305, 324-25 (observing that patent examiners get credit for "disposal" only when the application is allowed or abandoned, not when it is repeatedly rejected).

[209] John W. Schoen, *U.S. Patent Office Swamped by Backlog*, Apr. 27, 2004, http://www.msnbc.msn.com/id/4788834/ (last visited Oct. 6, 2005).

[210] *See infra* Part IV.C.7 (discussing the implications of this prediction).

3. Patent "Thickets"[211] Will Continue to Grow

The patent portfolio theory also predicts that certain components of the cost of innovation will increase in the future. As we explained above, to achieve an effective portfolio, firms must obtain a significant number of related patents.[212] The concentration of related patents in the hands of certain firms will raise the information and transaction costs associated with innovation. In a portfolio-driven environment, innovators will be forced to spend more time acquiring information about preexisting patents[213] and negotiating licenses with their holders. As several commentators have pointed out, in such a patent-intensive environment, one should also expect occasional holdup problems and bargaining failures.[214] As a result, innovation becomes more costly, at least for firms that do not have strong patent portfolios of their own.[215]

The portfolio theory not only explains the existence of "patent thickets," but also suggests that the problem is highly unlikely to go away. As we have shown, a strong patent portfolio yields substantial benefits to its holder. Hence, profit-maximizing firms will continue to

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[211] "Patent thickets" refer to the fact that in many areas of technology, great numbers of related patents exist at any particular time, and many might have applicability to any commercial product. *See, e.g.*, Carl Shapiro, *Navigating the Patent Thicket: Cross Licenses, Patent Pools, and Standard Setting*, *in* 1 INNOVATION POLICY AND THE ECONOMY 119, 119 (Adam B. Jaffe et al. eds., 2001) (explaining that a "patent thicket" occurs when many patents apply to a single product); James Bessen, *Patent Thickets: Strategic Patenting of Complex Technologies* (2004) (working paper, on file with authors) (same).

[212] *See supra* Part II.

[213] On the sources of information costs, see Clarisa Long, *Information Costs in Patent and Copyright*, 90 VA. L. REV. 465, 474-82 (2004).

[214] *See, e.g.*, Michael A. Heller & Rebecca S. Eisenberg, *Can Patents Deter Innovation? The Anticommons in Biomedical Research*, 280 SCI. 698, 699 (1998) (suggesting that a "proliferation of patents on individual [gene] fragments" will lead to the underuse of research materials and the inhibition of research); Josh Lerner, *Patenting in the Shadow of Competitors*, 38 J.L. & ECON. 463, 465 (1995) (demonstrating that the threat of litigation deters smaller firms from entering areas of research where larger firms hold patents); Arti K. Rai, *Fostering Cumulative Innovation in the Biopharmaceutical Industry: The Role of Patents and Antitrust*, 16 BERKELEY TECH. L.J. 813, 831-38 (2001) (exploring anticompetitive problems related to patents); Shapiro, *supra* note 211, at 124-26 (discussing the holdup problem).

Notwithstanding the growing academic concerns about the adverse effect of intense patenting on innovation, the only empirical study to date found a surprisingly small number of holdups in innovation. *See* Cohen et al., *supra* note 46, at 25 ("Firms do not, however, build such patent fences because individual patents effectively prevent imitation or substitution, but because they do not."). Of course, this does not mean that bargaining costs have not since risen as a result of the higher number of patents.

[215] *See infra* Part IV.A.2 (discussing in detail the impact of the portfolio theory on small firms).

accumulate related patents and ignore the costs that their actions impose on other innovators. Furthermore, no individual firm, acting alone, can change this dynamic. Accordingly, the portfolio theory confirms academic concerns about the increased cost of innovation and implies that the problem of patent thickets will not go away.[216]

4. Patent Litigation Will Become More Complex and Costly

Another important prediction we can make using the patent portfolio theory is that patent litigation will become more complex in the future. Our analysis underscores the importance of scale in portfolio construction. As corporations amass sizeable yet concentrated portfolios, it becomes ever more likely that infringement suits will involve increasingly large numbers of patents. One result of the interrelatedness of the individual patents in a portfolio is that a product or technology that infringes one patent is likely to infringe others. Similarly, because portfolios are designed with defensive purposes in mind, it is quite likely that, in cases that go to litigation, defendants will counterclaim by alleging infringements by the plaintiff.

Note, though, that we do not argue that there will necessarily be an increase in the number of litigated cases; only that the cases that go to court will become more complex. The effect of patent portfolios on the number of litigated cases is difficult to determine and we do not feel that we can make accurate predictions about it. The portfolio theory can have several effects on the number of litigated cases. One may intuit that the rise in the number of portfolios will lead to more litigation. Recall, however, that our analysis suggests that patent portfolios may actually serve to keep potential litigants at bay.[217] Small companies and new entrants who are threatened with an infringement suit may choose to avoid the cost of litigation and settle outside of the court.[218] As between large companies, they too may prefer not to engage in a battle of the titans with a competitor and may instead

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[216] *But see* Richard A. Epstein & Bruce N. Kuhlik, *Navigating the Anticommons for Pharmaceutical Patents: Steady the Course on Hatch-Waxman* 3 (Univ. of Chicago Law School, Olin Working Paper No. 209, 2004), *available at* http://www.law.uchicago.edu/Lawecon/WkngPprs_201-25/209.rae-bk.anticommons.pdf (arguing that recent academic concerns are overstated).

[217] *See supra* Part II.B.1.c.

[218] Patent litigation is notoriously expensive, and also has the potential to drag on for years. *See, e.g.*, Lerner, *supra* note 214, at 470-71 (discussing the costs of patent litigation); Manny D. Pokotilow, *Why Alternative Dispute Resolution Should Be Used for Intellectual Property Disputes*, INTELL. PROP. & TECH. L.J., July 2004, at 17, 17 (noting that "it is rare for a patent infringement action to cost less than $1 million for each party by the time it is ultimately resolved" and emphasizing that a case could potentially stretch on for decades). On the costs of litigation generally, see Gillian K. Hadfield, *The Price of Law: How the Market for Lawyers Distorts the Justice System*, 98 MICH. L. REV. 953 (2000).

reach a mutually beneficial licensing deal. Indeed, our prediction about the increased complexity of patent litigation implies that the cost of future litigation will also be higher. The high cost of litigation could discourage even large companies from litigating. Hence, we cannot say in the abstract whether the number of cases that reach a decision will increase or decrease, and we leave this question to future empirical research.

5. Mass-Licensing Arrangements Will Proliferate

The portfolio theory also suggests that mass licensing of patents will become more common in the future. Due to the interrelatedness of the individual patents within a portfolio, securing a license for a single patent may not adequately protect the licensee from future litigation. Also, the uncertainty that attends the inventive process makes it very difficult for licensees in the early stages of research to isolate a single patent or two that they must license to clear the way for their own work.

In a portfolio-driven environment, mass licensing has two key advantages over individual licensing. The first advantage, which we have already explained, pertains to risk: mass-licensing diminishes exposure to lawsuits. The second, and perhaps more significant advantage, relates to transaction costs. Mass-licensing effects a transaction cost reduction relative to individual licensing. Rather than engaging in numerous license negotiations, each involving a single patent, it makes more sense for companies to economize on transaction costs by negotiating a single license over multiple patents.[219] In extreme cases, licensees may even find it in their best interest to license entire portfolios. Doing so can save them the costs of carefully studying each individual patent in the portfolio and allows them to use all the patents they might need after completing a single transaction.

Of course, the attractiveness of mass-licensing will vary in individual cases. Some licensees may find mass-licensing unappealing as it raises the fee they have to pay the licensor. We do not predict, however, that mass licensing will always dominate individual licensing in the future. Rather, we argue that in a portfolio-driven business environment, mass licensing will be a common phenomenon.

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[219] *See* Grindley & Teece, *supra* note 114, at 9 (explaining that the "portfolio approach reduces transaction costs").

6. The Patent System Will Increasingly Favor Large, Well-Funded, Incumbent Players

The portfolio theory also enables us to make a key distributional prediction. Our analysis indicates that holders of strong patent portfolios have an inherent advantage over competitors that hold a small number of individual patents. If portfolio strength is positively correlated with firm size, then one should expect that large firms will play a dominant role in shaping the future of innovation. Furthermore, our analysis implies that entry into a patent-based industry is more difficult than is currently assumed. In the paradigmatic case, new companies that seek to enter a certain industry will have relatively few patents, which in turn will make it very difficult for them to compete with incumbents. Not only are new entrants more vulnerable to the threat of litigation, but they also face a higher cost structure for producing additional innovation. As we have explained, a strong portfolio both lowers the cost of subsequent in-house innovation[220] and helps attract related external innovation.[221] New entrants have fewer patents to rely on in producing future innovation. Also, new entrants with a small number of patents cannot as easily engage in cross-licensing—the most cost-effective method of mass-licensing.[222]

The competitive advantage portfolios bestow upon incumbents, and possibly large firms, may also have important welfare implications. Several studies have suggested that small firms and new entrants tend to produce more socially valuable innovation.[223] These studies are subject to debate. But if they prove correct, they give rise to a concern that patent portfolios actually dilute the quality of innovation. Regardless, the inherent advantage that portfolios bestow on incumbents clearly has antitrust implications.[224]

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[220] *See supra* Part II.B.1.a.

[221] *See supra* Part II.B.1.b.

[222] *See generally* Shapiro, *supra* note 211, at 130 (arguing that cross-licensing permits more effective innovation).

[223] *See, e.g.*, Barnett, *supra* note 185, at 1285-88 ("Small firms and other entrants carry out a disproportionate share of entrepreneurial research."); Wesley M. Cohen & Steven Klepper, *Firm Size Versus Diversity in Achievement of Technological Advance*, *in* INNOVATION AND TECHNOLOGICAL CHANGE: AN INTERNATIONAL COMPARISON 183-203 (Zoltan J. Acs & David B. Audretsch eds., 1991) (describing how small firms may be better situated to "stimulate creativity and agility in response to economic opportunity"); Richard J. Rosen, *Research and Development with Asymmetric Firm Sizes*, 22 RAND J. ECON. 411, 419-21 (1991) (finding that small firms have a greater incentive to create revolutionary technologies).

[224] *See infra* Part V.C.

7. The Value of Individual Patents Will Become More Obscure (and Increasingly Irrelevant)

Finally, we would like to note the effect of our portfolio theory on individual patents. As patent portfolios become more prevalent, it will be increasingly difficult to assess accurately the stand-alone value of individual patents. Two effects are liable to produce this result. First, a key teaching of the portfolio theory is that patents should be examined at the portfolio level. Specifically, the theory demonstrates that the value of individual patents may be enhanced by related patents in the same portfolio. Hence, we expect that, in the future, analysts and investors will focus more on portfolios and less on individual patents.

Second, as we have explained, inventors' desire to attain a robust patent portfolio means that the rate of filings will remain high in the future, and the quality of the PTO's review will remain low. The low-quality of review means that a significant number of the patents approved by the PTO may in fact be invalid. Consequently, third parties will have to discount the value of issued patents. We emphasize that the low quality of review will also make it difficult to calculate portfolio values. Yet, in many cases, the invalidation of one of the patents in a portfolio might not have a dramatic effect on the overall value of the portfolio.

V. POLICY OPTIONS FOR THE PATENT PORTFOLIOS ERA

In light of the array of predictions noted above, the rise of patent portfolios portends—in our view—a more *costly* patent system: one with far more patents of often-irrelevant individuated value, higher transaction costs, and a continued sidelining of the PTO's role in screening for quality inventions. Further, if (as we think is likely) the rise of patent portfolios increases the net costs of innovation—by forcing firm R&D efforts to increasingly adjust and account for the patenting behavior of other firms, or by simply increasing the input costs of crucial (patented) information—then the net effects of patent portfolios on innovation may well be negative. But perhaps most importantly, the competition-related effects of patent portfolios may be difficult to overstate. As firms increasingly use portfolios as ever more effective tools for the domination of innovation markets, the results would seem to be (1) a broad consolidation and centralization of inventive activity within large firms or groups of firms organized around jointly developed patent portfolios,[225] and (2) the use of portfolios to

[225] Of course, the classic Schumpeterian view is that this trend might be beneficial to the rate of innovation. *See generally* SCHUMPETER, CAPITALISM, SOCIALISM, AND DEMOCRACY, *supra* note 184 (describing this view). And yet many economists have

achieve real market power or otherwise cartelize markets.[226] Given this understanding—that patent portfolios have substantial and at least potentially quite negative effects—we now turn to the question of adjusting policy for a portfolio-based era.

A. *The Direct Regulation of Patent Portfolios*

A first set of policy options includes a range of efforts to directly regulate the growth and deployment of patent portfolios.

1. Patent Holding Caps

A trivially simple example would be a limit or "cap" on the total patent holdings available to any single firm. Such caps could be implemented either on a yearly basis (which would restrict the growth over time of portfolios) or calculated as a grand total. The actual limits might be determined in a variety of ways: across-the-board (i.e., the same cap for all firms); calculated as a percentage of firm size (for example, as a fraction of gross revenues or R&D outlays); or based on prior-year numbers (such as the average yearly increase in holdings).

The advantages of holdings caps are their relative simplicty and likelihood of at least some effectiveness in limiting firms' ability to create significant patent portfolios. The disadvantages, however, are important. For one thing, a simple cap system would almost certainly preclude consideration of important innovation-related factors, such as industry, technology, firm R&D efficiency, and more.[227] Another

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found the opposite to be true: that small firms seem to be more efficient vehicles for innovation. *See, e.g.*, Barnett, *supra* note 185, at 1288-89 ("[S]mall firms tend both to be more efficient innovators (as measured by the number of innovations per dollar of R&D or per employee) and to account for a disproportionate share of innovations (especially, significant innovations) in many industries."). Our point here is that, irrespective of the innovation-rate effects, the diminution of competition in the market for new innovations is likely to have negative consequences.

[226] As has been often observed, patents and other intellectual property rights rarely, if ever, confer monopoly-like market power. *See, e.g.*, R. Polk Wagner, *Information Wants to Be Free: Intellectual Property and the Mythologies of Control*, 103 COLUM. L. REV. 995, 1013-15 (2003) (describing the market forces that limit the monopoly effects of intellectual property rights); *see also* Edmund W. Kitch, *Elementary and Persistent Errors in the Economic Analysis of Intellectual Property*, 53 VAND. L. REV. 1727, 1730-31 (2000) (discussing the relative rarity of patents that confer an economic monopoly); Edmund W. Kitch, *Patents: Monopolies or Property Rights?*, 8 RES. L. & ECON. 31, 31 (1986) (asserting that a patent "confers a property right which . . . is subject to competitive market pressures"). Patent portfolios, of course, may change that understanding. *See supra* Part II.B.

[227] One could, of course, imagine a portfolio caps system that attempted to include such information. For example, the capping scheme could be tailored for an industry or technological area. Or the determination of caps could be weighted in fa-

problem is that administration of such a system might be more difficult than it initially appears: firms could alter corporate structures, form new entities, or otherwise seek to evade firm-based limits on patenting. But perhaps the biggest concern with caps is their potential distorting effect on innovation. By limiting patenting by firms on a non-invention basis, a portfolio caps scheme could (if caps were set too low) significantly reduce incentives to invent, or drive more invention protection towards trade secrecy.[228] Indeed, because holding caps are triggered by factors that are unrelated to any particular invention, the limits will operate to exclude both high-quality (more desirable) and low-quality patents. Consequently, in some cases their operation will be perverse, inasmuch as they fully allow (as long as the caps are not reached) the sort of low-quality patenting that is a hallmark of the modern patent portfolio era.

For these reasons, we are not convinced that portfolio caps, by themselves, are an appropriate solution at this point.

2. Differential Fees

A related, albeit less rigid, approach to controlling patent portfolios is to implement a fee structure for the patent system that incorporates information about firm patent holdings. For example, the standard filing fee for patent applications could be subject to a multiplier, where the multiplier is related to the firm's current patent holdings.[229] Firms with larger holdings would face higher fees, thereby providing some disincentive to adopt a high-volume, low-quality patenting strategy. A similar approach could also be adopted with respect to maintenance fees: the cost of extending the life of a patent could be related to firms' patent holdings—again, with major patent holders paying more.

As with patent holding caps, a differential fees system would appear to be at least reasonably likely to have an effect on the incentives for firms to seek patent portfolios. But many of the same problems are present here as well: the effects might be evaded by manipulation of corporate structures; the scheme might distort the pace of innovation in unexpected ways; and it could operate to limit the filing of both high-quality and low-quality patent applications. And even the

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vor of smaller firms (allowing them more patents). Unfortunately, as more complexity is added to the system, a chief advantage of the system—its simplicity—is lost, and the potential costs of error are likely to increase, not decrease.

[228] Note that if caps are set too high, the system will be ineffective for its intended purpose.

[229] Obviously, the various metrics related to patent holding discussed in connection with patent holding caps could be utilized here as well.

chief advantage of a differential fee system—the flexibility inherent in a system of fees rather than absolute limits on patent filings—is an important disadvantage, because without good information about the demand elasticity of patent filings, it will be difficult to determine the appropriate fee levels. For example, consider that the current base-level patent filing fee for most firms is $300,[230] while even a low-cost patent prosecution can easily cost over $10,000 in attorney's fees.[231] This suggests that significant alterations to the incentives to file patent applications would only be realized with very substantial changes (of perhaps orders of magnitude) in the fee structure.[232]

As with the patent holding caps noted above, we are concerned that the effectiveness of differential fees, by themselves, would be too uncertain to justify the potential problems, although they are worth further consideration and study—especially as a part of an array of policy solutions.

B. *Addressing Portfolio Strategies Ex Ante*

A second important—and potentially very effective—policy approach is to tailor the legal regime of the patent law to generate ex ante incentives (those prior to or during patent prosecution) that undermine firms' interests in pursuing a high-volume, low-quality patenting strategy. This approach was outlined by one of the authors in *Reconsidering Estoppel: Patent Administration and the Failure of* Festo, wherein the venerable doctrine of "prosecution history estoppel" was explained as an important mechanism for forcing patentees to produce sufficient information about their patented invention at an early stage.[233] Indeed, the problem of patent portfolios, where large numbers of low-quality patents are obtained with little regard to their validity or actual value, is an especially compelling consequence of what one of the authors has described as the "prosecution externality": the

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[230] USPTO FY 2005 Fee Schedule (Oct. 1, 2005), http://www.uspto.gov/web/offices/ac/qs/ope/fee2005oct01.htm. "Small entities"—generally individual inventors, non-profits, and very small businesses—qualify for a 50% discount on fees. *Id.*

[231] Lemley, *supra* note 3, at 1498.

[232] We note that the PTO's 2005 Fee Structure does implement a form of fee-differentiation, albeit on the basis of application complexity and length rather than any firm-based measures. For example, the new fee structure has sharply escalating charges for numbers of claims and total sheets of the specification and drawings. USPTO FY 2005 Fee Schedule, *supra* note 230.

[233] *See generally* Wagner, *supra* note 34, at 169-71. Prosecution history estoppel is a rule which serves to prevent a patentee from relinquishing subject matter coverage during patent prosecution and later claiming—via the doctrine of equivalents—coverage of such subject matter during an enforcement proceeding. *See, e.g.*, Festo Corp. v. Shoketsu Kinzoku Kogyo Kabushiki Co., 535 U.S. 722, 733-35 (2002) (describing the doctrine).

ability of patentees to avoid most of the costs of uncertain, poorly drafted, and incompletely disclosed patents.[234] That patentees have insufficient incentives to seek only high-quality patents (and fully disclose them) is surely a major driver of the growth of patent portfolios we identify in this Article.[235]

In the portfolio context, there are several possibilities for adjustments to legal rules that should yield better ex ante incentives. First, as discussed in *Reconsidering Estoppel*, by reducing patent scope for those patents that are drawn too broadly in their initial application (i.e., "overclaimed"), a robust doctrine of prosecution history estoppel would be valuable.[236] Similarly, Joe Miller has followed this approach in calling for a series of rules for patentees to disclose additional information (such as preferred definitions of key terms) that would be very helpful for claim construction.[237] Additionally, the ex ante effects of patent doctrines such as the "dedication" rule,[238] the "first-to-invent" rule,[239] and the "written description" requirement[240] have not been fully explored, but all present significant opportunities to implement a legal regime that forces more information from patentees at an earlier stage.

The value of such information-forcing rules in patent law is multifaceted, and could be especially important in this context. First, and most obviously, by generating incentives to more fully disclose, define,

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[234] Wagner, *supra* note 34, at 222-25.

[235] *See supra* Part II (documenting the rise of patent portfolios).

[236] Wagner, *supra* note 34, at 164-67.

[237] Joseph Scott Miller, *Enhancing Patent Disclosure for Faithful Claim Construction*, 9 LEWIS & CLARK L. REV. 177 (2005).

[238] The dedication rule specifies that subject matter that is disclosed in a patent document, but not claimed in the claims, is "dedicated to the public" and thus unavailable to the patentee during an enforcement proceeding. *See* Johnson & Johnston Assocs. v. R.E. Serv. Co., 285 F.3d 1046, 1051 (Fed. Cir. 2002) (en banc) (per curiam) (noting the existence of the rule).

[239] The first-to-invent rule (a virtually unique feature of the U.S. patent system) assigns patent rights to the first inventor to conceive of an invention, rather than the first inventor to apply for a patent on the invention. 35 U.S.C. § 102(g) (2000).

[240] The written description requirement limits patentees to claiming only those portions of their inventions that they demonstrate (via their written disclosures) they actually possessed at the time of patent filing. *See, e.g.*, Univ. of Rochester v. G.D. Searle & Co., 358 F.3d 916, 921 (Fed. Cir.) (discussing the written description requirement), *reh'g en banc denied*, 375 F.3d 1303 (Fed. Cir.), *cert. denied*, 125 S. Ct. 629 (2004); Enzo Biochem, Inc. v. Gen-Probe, Inc., 296 F.3d 1316, 1323-24 (Fed. Cir. 2002) (same); Enzo Biochem, Inc. v. Calgene, Inc., 188 F.3d 1362, 1371 (Fed. Cir. 1999) (same); Regents of the Univ. of Cal. v. Eli Lilly & Co., 119 F.3d 1559, 1566-67 (Fed. Cir. 1997) (same); *In re* Deuel, 51 F.3d 1552, 1559 (Fed. Cir. 1995) (same); *In re* Goodman, 11 F.3d 1046, 1050 (Fed. Cir. 1993) (same); Fiers v. Rivel, 984 F.2d 1164, 1170-71 (Fed. Cir. 1993) (same); Amgen, Inc. v. Chugai Pharm. Co., 927 F.2d 1200, 1212 (Fed. Cir. 1991) (same).

articulate, and tailor one's invention, an ex ante approach will necessarily yield higher quality patents that are easier for all parties (the PTO, competitors, and even the patentee) to fully evaluate.[241] Second, an ex ante approach will raise the costs of prosecuting low-value patents in particular, because the generation of additional information will serve to further weaken (and obviously so) such patents. Third, an ex ante approach will raise the costs of patent acquisition generally (though the penalty will fall more heavily on low-quality patents), which will force firms to allocate patenting resources differently. Fourth, an ex ante approach will enhance the PTO's screening functions, forcing patentees to more seriously engage with the PTO at an early stage of the patenting process.[242] These factors, taken together, suggest that a serious implementation of an ex ante approach to the patent law could provide important disincentives to pursue a high-volume, low-quality patenting strategy—and accordingly could limit the attractiveness of building significant patent portfolios.

C. *Tailoring Antitrust Law*

Antitrust law constitutes another mechanism that may be employed to curb the potential anticompetitive effects of patent portfolios and level the playing field for small firms. The inherent tension between patent law and antitrust law is a well-known problem that has spawned an extensive body of scholarship. As Louis Kaplow wrote two decades ago: "The intersection of antitrust law and patent policy has proved to be a source of perpetual confusion and controversy since the passage of the Sherman Act nearly a century ago."[243] Patent law aims to promote innovation by bestowing upon inventors a broad power to exclude; antitrust law aspires to enhance competition by striking down exclusionary practices.

While antitrust scholars invested considerable efforts in devising creative schemes to reconcile the patent and antitrust laws,[244] courts often sidestepped the patent-antitrust conundrum by postulating that as long as patentees act within the scope of a patent, they will gener-

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[241] *See* Wagner, *supra* note 34, at 212-14 (discussing the advantages to all parties of more complete information in the patent process).

[242] *See id.* at 225-28 (exploring the effect of prosecution history estoppel on the effectiveness of the PTO's administration function).

[243] Louis Kaplow, *The Patent-Antitrust Intersection: A Reappraisal*, 97 HARV. L. REV. 1813, 1815 (1984).

[244] For a comprehensive discussion of the various theoretic proposals, see Michael A. Carrier, *Unraveling the Patent-Antitrust Paradox*, 150 U. PA. L. REV. 761, 787-99 (2002).

ally be exempt from antitrust liability.[245] For example, in *In re Independent Service Organizations Antitrust Litigation*, the Federal Circuit stated that "[i]n the absence of any indication of illegal tying, fraud in the Patent and Trademark Office, or sham litigation, the patent holder may enforce the statutory right to exclude others from making, using, or selling the claimed invention free from liability under the antitrust laws."[246] As Michael Carrier correctly pointed out, this approach promotes "clarity for . . . inventors, and future courts and lawyers, [but only at the cost of] deferring excessively to the patent . . . ."[247]

The prevailing judicial view presumably relies on the correct assumption that individual patents rarely confer significant market power.[248] The aggregation of individual patents into portfolios poses several new challenges. As we pointed out, portfolios are essentially super-patents whose coverage extends far beyond that of any of the individual patents comprising them. More importantly, portfolio holders can affect their rivals in ways individual patent holders cannot.

In a recent article, Daniel Rubinfeld and Robert Maness discuss the various ways by which portfolio holders can raise rivals' costs.[249] First, large portfolio holders can engage rivals in complex litigation, forcing them to incur substantial costs and undermining their ability to market competing products.[250] Furthermore, because the portfolio holder controls the litigation process, the holder can choose to assert patent claims that are cheaper to prosecute than to defend. Second, portfolio holders may use the threat of litigation to force rivals to buy package licenses that cover patents that the rivals neither need nor

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[245] *See, e.g., id.* at 788 ("The courts' most popular solution to the patent-antitrust conflict is centered on the 'scope' of the patent. Throughout the past century and even now, courts have held that a patentee's actions within the scope of the patent are immune from antitrust scrutiny, while those outside the scope are invalid.").

[246] 203 F.3d 1322, 1327 (Fed. Cir. 2000); *see also* SCM Corp. v. Xerox Corp., 645 F.2d 1195, 1206 (2d Cir. 1981) ("[W]e hold that where a patent has been lawfully acquired, subsequent conduct permissible under the patent laws cannot trigger any liability under the antitrust laws.").

[247] Carrier, *supra* note 244, at 778.

[248] *See* Walker Process Equip., Inc. v. Food Mach. & Chem. Corp., 382 U.S. 172, 177-78 (1965) (finding that, without a clear definition of the relevant market, it was impossible to say that the patent at issue conferred any power over the market); Am. Hoist & Derrick Co. v. Sowa & Sons, 725 F.2d 1350, 1367 (Fed. Cir. 1984) (observing that "patent rights are not *legal monopolies* in the antitrust sense of that word").

[249] Daniel L. Rubinfeld & Robert Maness, *The Strategic Use of Patents: Implications for Antitrust* 5-7, http://www.cerna.ensmp.fr/cerna_regulation/Documents/ColloqueAntitrust2004/Rubinfeld-Presentation.pdf (2004).

[250] *See id.* at 5 (noting that a firm can raise rivals' costs by filing or threatening to file patent suits).

want.[251] This strategy is especially beneficial to portfolio holders if the royalties are purely based on the number of patents in the package.[252]

While raising rivals' costs improves the lot of portfolio holders by enabling them to gain market share, and in extreme cases drives competitors out of the market, it adversely affects price competition.[253] The higher costs incurred by competitors limit their ability to lower prices, and lessen the resources they can invest in R&D. Hence, raising rivals' costs has negative effects on both static and dynamic efficiency.

Worse yet, Rubenfeld and Maness also argue that a strategy of raising rivals' costs may serve as a collusion facilitating device.[254] Rather than contesting the cost increase due to package licensing, each portfolio holder can agree to pay the required royalties and raise its own prices. This way, all portfolio holders could collect supra-competitive rents.[255]

Finally, Rubenfeld and Maness suggest that the thicket effects accompanying many patent portfolios[256] make it easier for the portfolio holder to extract concessions from rivals either by threatening litigation or by engaging in package licensing. Specifically, the uncertainty created by patent thickets increases information costs for rivals, making it riskier and more expensive to try to design around patents.

Yet, at the end of the day, Rubenfeld and Maness do not call for a per se prohibition on package licensing. This is no accident. Consistent with the view expressed by other scholars,[257] Rubenfeld and Maness acknowledge that package licensing may have procompetitive effects in some circumstances. Indeed, the Antitrust Guidelines for the Licensing of Intellectual Property provide that cross-licensing and pooling arrangements "may provide procompetitive benefits by integrating complementary technologies, reducing transaction costs,

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[251] *Id.*

[252] *See id.* at 10 ("Per-unit royalties raise marginal costs, and can lead to higher product prices.").

[253] *Id.* at 6.

[254] *Id.*

[255] *See id.* at 11-17 (outlining, in a case study, the use of package licensing).

[256] *See supra* Part IV.C.3.

[257] *See, e.g.*, Robert P. Merges, *Contracting into Liability Rules: Intellectual Property Rights and Collective Rights Organizations*, 84 CAL. L. REV. 1293, 1319 (1996) (highlighting the potential of patent pools to lower transaction costs by facilitating "licensing and royalty splitting, and also extensive cross-licensing among members") (emphasis omitted).

clearing blocking positions, and avoiding costly infringement litigation."[258]

Accordingly, a determination of the net effect of package licensing and pooling arrangements on competition requires a careful analysis of the pro- and anti-competitive effects of these practices. It is quite possible that the outcome of the analysis would vary from one industry to another. For example, Michael Carrier proposed that "cross-licenses and patent pools are reasonably necessary to circumvent bottlenecks in the semiconductor and biotechnology industries," as long as such arrangement targets "thickets of blocking patents."[259] As we noted, cross-licensing and patent pools will often benefit dominant industry participants at the expense of smaller rivals. Hence, an industry-by-industry analysis would require the courts and the antitrust authorities to assess the relative contributions of large and small companies to the relevant industry or technological sector. Given limited resources and highly imperfect information, it may be unrealistic to expect the courts and the antitrust authorities to successfully perform this examination. Since antitrust intervention is costly and its effectiveness in curbing the anticompetitive effects is questionable, such intervention should be used sparsely.

D. *Letting the Market Sort* It *Out*

In light of the limited ability of the antitrust laws to provide an adequate response to the challenges presented by patent portfolios, it seems inevitable that the market will play a large part in shaping the path of future innovation. While our analysis suggests that patent portfolios give large companies an inherent advantage over smaller competitors, it does not imply that small and startup companies will disappear from the scene. Small companies will continue to innovate and thrive even in a portfolio-dominated environment for two principal reasons. First, small companies can "fill in" gaps in the portfolios of large companies by coming up with innovations that complement their larger rivals' portfolios.[260] Second, small companies can outperform their more established rivals by focusing their inventive efforts on disruptive technologies.

In a recent book, Clayton Christensen demonstrates the vulnerability of established and well-managed firms to disruptive technolo-

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[258] U.S. DEP'T OF JUSTICE, ANTITRUST GUIDELINES FOR THE LICENSING OF INTELLECTUAL PROPERTY § 5.5 (1995), http://www.usdoj.gov/atr/public/guidelines/0558.pdf.

[259] Michael A. Carrier, *The Patent-Antitrust Paradox Through Tripartite Innovation*, 56 VAND. L. REV. 1047, 1105 (2003).

[260] Thanks to Rob Merges for suggesting this approach to us.

gies.[261] According to Christensen, leading firms are well suited to dealing with sustaining technologies: innovations that "improve the performance of established products."[262] But they are ill-equipped to handle disruptive "technologies that result in *worse* product performance, at least in the near-term."[263] Disruptive technologies start as cheaper, lower performance alternatives to established technologies. They typically gain a foothold in the low end of the market and, because they do not appeal to the high margin customers market, incumbents initially tend to disregard them. Gradually, however, disruptive technologies improve, without a large increase in cost, until they rival and ultimately replace established technologies.

Among other examples, Christensen uses the evolution of computer technology to substantiate his theory. According to Christensen, "IBM, the industry's first leader," and its competitors, failed to respond to the emergence of the minicomputer. Since "[t]heir customers had no use for it" and "it promised lower, not higher, margins," mainframe makers "ignored the minicomputer for years, allowing a set of [new] entrants—Digital Equipment, Data General, Prime, Wang, and Nixdorf—to create and dominate that market."[264] Minicomputer manufacturers enjoyed a period of prosperity that ended abruptly when a new disruptive technology, the desktop personal computer (PC), was introduced by another "set of entrants, including Apple, Commodore, Tandy, and IBM."[265] The dominance of the latter group was disrupted, in turn, by the introduction of the portable computer by entrants "like Toshiba, Sharp, and Zenith."[266]

Christensen's account of disruptive technology suggests that there will always be a niche for small innovators in technological markets. It also suggests that disruptive technologies provide some sort of a safe haven for small innovators. This means that despite the advantages presented by patent portfolios, small innovators will not be driven out of the market entirely. Instead, in a portfolio-dominated environment, one should expect to see small firms either cooperating with large portfolio holders by complementing their portfolios or competing with them by focusing on disruptive technologies.

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[261] CHRISTENSEN, *supra* note 36.

[262] *Id.* at xv. Christensen notes that "rarely have even the most radically difficult sustaining technologies precipitated the failure of leading firms." *Id.*

[263] *Id.*

[264] *Id.* at 108-09.

[265] *Id.* at 109.

[266] *Id.*

That we think the net effect of patent portfolios is likely to be negative does not mean, however, that they have no redeeming qualities whatsoever. Indeed, under some circumstances, the rise of patent portfolios might have beneficial effects, such as the following:

Additional disclosure. Because each patent contains an "enabling" disclosure of the relevant invention, the dramatic growth in issued patents should represent a corresponding growth in useful, innovation-related disclosure, thereby building the total quantity of available information.[267] This might be particularly important coupled with the recently decreased time delay between patent application filing and publication,[268] meaning that more information in patent documents will be available sooner. Unfortunately, this benefit will be offset to some degree by the decline in the average value of individual patents—meaning that the marginal additional value of the information in patents will decline.[269]

Encouraging Broad(er) Research Efforts. Because of the advantages of diversity as well as scale noted in Part II.B, portfolio-savvy firms are likely to have additional incentives to broaden, albeit slightly, their research efforts, so as to support a patenting strategy that encompasses both the "core" researched technologies and those that are closely related. This in turn is likely to have the beneficial effect of encouraging researchers to think beyond the narrow confines of present research, and seek advantageous related technologies as well.

Keeping Firms in the Patent System. If nothing else, the emergence of patent portfolios suggests that engaging in the patent system is viewed as a worthwhile endeavor by most firms. Thus, rather than resorting to trade secrecy or other means of protecting innovations, it appears that firms are increasingly participants in the patent system—although, as this Article establishes, perhaps not in the way that is conventionally understood. This in turn implies two possibilities: (1) the fundamental social value of the patent system as an incentive to disclose inventions remains valid, and (2) policy changes to the patent system are likely to have substantial impact.

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[267] *See* Wagner, *supra* note 226, at 1007 (noting how an invention, once disclosed, produces more information than the invention itself).

[268] In the Domestic Publication of Foreign Filed Patent Applications Act of 1999, Pub. L. No. 106-113, § 4502, 113 Stat. 1501A-561, -561 (codified at 35 U.S.C. § 122 (2000)), Congress amended the practice in which pending applications remained confidential by requiring that most patent applications be published eighteen months after their submission to the USPTO.

[269] *See supra* Part II.B.

CONCLUSION

This article has set forth a new theory of patent value, responding to growing evidence—both empirical and theoretical—that the traditional appropriability theory of patents is fundamentally incomplete in the modern innovation environment. We find that for patents, the whole is greater than the sum of its parts. The true value of patents lies not in their individual worth, but in their aggregation into a collection of related patents—a patent portfolio.

We find that the benefits of patent portfolios are so significant as to suggest that the decision by a firm to seek additional patents is essentially unrelated to the expected value of the individual patents. Firms engaging in strategic patent portfolio building will, therefore, typically seek to obtain a large quantity of related patents, rather than evaluating their actual worth individually. The result—which we find widely recognized in commercial circles—is that the modern patenting environment exhibits (and requires) a high-volume, portfolio-based approach that is at odds with scholars' traditional assumptions.

The implications of the patent portfolio theory are important and widespread. First, the explanatory power of the theory allows resolution of not only "the patent paradox," but many of the otherwise puzzling observable patterns in the modern patenting environment, such as firm-size differences in patent intensity and litigation rates. Second, the patent portfolio theory neatly complements the prior theories that have sought to explain modern patent value, strengthening their relationship with the reality of patenting and confirming that the value of patents has expanded beyond traditionalist notions. Third, the patent portfolio theory allows a number of important predictive insights into future trends in the patent system, allowing policymakers and scholars to frame the future problems within a range of likely outcomes. Finally, our analysis of the patent portfolio theory does not suggest a better, brighter future for the patent system, but it does build a foundation for the important policy-related work that springs from this initial theoretical treatment.