Patent Signals

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Courts and commentators often treat intellectual property as if the private value of the rights stemmed entirely from the control legal rules conferred over the protected subject matter. While the literature has devoted an enormous amount of time, paper, and ink to the discussion of whether legal rules grant the optimal amount of exclusivity, it has not considered whether it has been examining all the functions of patents. This Article provides a new general framework for analyzing the function and effect of intellectual property rules. Rather than focusing on patents as a mechanism for privatizing information, this Article instead frames patents as a means of credibly publicizing information. Patents can reduce informational asymmetries between patentees and observers. Under some circumstances, the informational function of patents may be more valuable to the rights holder than the substance of the rights. The Article presents a model of patents as a signaling mechanism and considers the multiple equilibria that could result from using patents to convey information. If an easily measurable firm attribute such as patent counts is positively correlated with other less readily measurable firm attributes such as knowledge capital, then patent counts can be used as a means of conveying information about these other attributes. Knowing this, firms may choose to obtain and use a portfolio of patent rights to signal information about themselves that would be more expensive to do through other means. Alternatively, firms can use the patent document itself to convey information that would not be as credible when revealed in other contexts. Patent signals can be ambiguous, however, reducing information costs along some margins but raising them along others. The Article concludes by exploring the efficiency implications of patents as informational mechanisms.

INTRODUCTION

Courts and commentators often treat intellectual property as if the private value of the rights stemmed entirely from the control legal rules conferred over the protected subject matter. Indeed, this assumption is used to justify the very existence of intellectual property protection. Inventions and artistic creations, if unprotected, become public goods once revealed. Legal rules allow individuals to maintain some elements of control over information that would otherwise be lost to the public domain. Individuals are assumed to be made worse off by revealing the information comprising the creative work. By granting exclusive rights to the creative work, legal rules make it pos-

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sible for creators to be compensated for that revelation. With these assumptions firmly in place, debate then proceeds over whether legal rules create the right amount of control over the protected subject matter.

Call this the simple view of intellectual property rights. The simple view frames intellectual property in general, and patents in particular, as an exchange of information for protection. Inventors disclose the information comprising the invention in exchange for being able to exclude others from using the information in certain ways, such as reproducing the invention. On this view, inventors should be loath to disclose any more information than necessary to obtain patent protection. Rational inventors should seek patent rights only when the expected rents from the patent outweigh the expected costs of disclosing the information. Faced with an array of regimes by which to protect their creations, rational inventors should choose the set of legal rules that maximizes their exclusionary rights and minimizes the amount and quality of information that must be revealed. If inventors expect that a trade secret regime (which does not involve revealing any information) will provide protection equal to or greater than patent rules (which require extensive revelation), then they should prefer to keep the invention a trade secret. If a patent provides only poor appropriability, it is likely to have little private value. Indeed, such a patent may have a negative private value if the value of the information revealed is greater than the rents the patent enables the inventor to capture. If an inventor could reap the same rents regardless of whether the invention was protected by a patent, then the inventor should not deliberately disclose information and spend money obtaining, defining, and enforcing patent rights. Thus, when inventors expect that patents will be costly to obtain and ineffective in allowing them to capture rents, we would not expect to see them demanding many patents.

And yet it is an undeniable fact that, when the value of intellectual property rights is framed purely in terms of exclusivity and rents, worthless patents abound. While the literature has devoted an enor-

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mous amount of time, paper, and ink to the discussion of whether legal rules grant the optimal amount of exclusivity, it has not considered whether it has been examining all the functions of patents. Are exclusionary rights the only thing that makes intellectual property valuable? Might rational inventors ever find intellectual property protection valuable for reasons other than capturing rents and maximizing control over the subject matter of the rights? Would rational actors ever prefer a set of legal rules that they believe confers less protection to a set of legal rules that they believe confers more protection? When inventors reveal valuable information for little protection, are they striking as bad a bargain as it may appear? As I will show in this Article, such questions become easier to answer if we relax the assumption that the private value of a patent is based solely on the ability to capture rents and exclude others from using the invention.

I challenge the traditional assumption that exclusivity is the alpha and the omega of the private value of patent rights. To do so, I move beyond the standard models that approach intellectual property as a two-dimensional set of rights and rents. In the following Article, I will build on the finance and corporate law literature to provide a new general framework for analyzing the function and effect of intellectual property rights. Rather than focusing on patents as a mechanism for privatizing information, I will instead frame patents as a means of credibly publicizing information. In the process, I will extend a simple insight overlooked by previous theories of intellectual property: Owners of intellectual property are usually actors in capital and labor markets as well as product markets. Patents can serve as a means of reducing informational asymmetries between patentees and observers. The ability to convey information credibly to observers at low cost is a highly valuable function of patents that has been completely overlooked in the literature.

A richer understanding of the role of patents in reducing information costs potentially has numerous practical and theoretical implications. Possession of a portfolio of intellectual property rights is an attribute that is voluntary, under a firm’s control, and readily measurable, at least along some margins. If an easily measurable firm attribute such as patent counts is positively correlated with other less readily measurable firm attributes such as knowledge capital, then patent counts can be used as a means of conveying information about these other attributes. Knowing this, firms may choose to obtain and use a
portfolio of patent rights to signal information about themselves that would be more expensive to convey through other means. Alternatively, firms can use the patent document itself to convey information that would not be as credible when revealed in other contexts. Intellectual property, therefore, derives value from more than just the entitlement to exclude. Under some circumstances, the signal sent by the patent may be more valuable to the rights holder than the substance of the rights. When we broaden our focus and consider the function of patents as a means of reducing information costs, patents that appear to be worthless under traditional exclusivity-based conceptions of value may turn out to have positive value after all.

This Article proceeds as follows. Part I sets out the existing conceptualization of the value of intellectual property rights and demonstrates the awkwardness of its underlying assumptions. Part II supplies a framework for analyzing intellectual property protection as something more than a package of incentives to create or control development of an invention. Part III takes insights from the finance and corporate law literature to demonstrate how patents can reduce informational asymmetries in capital markets, thereby potentially reducing information costs. This Part presents a model of patents as a signaling mechanism and considers the multiple equilibria that could result from using patents to convey information. It also discusses the potential ambiguities of patent signals. Part IV explores the implications of a theory of patents as a means of reducing information asymmetries. It considers how patents may reduce information costs along some margins but raise them along others. The Article concludes that intellectual property rights can serve an informative function and suggests that we need to explore further the ultimate efficiency of patents as informational mechanisms.

I. THE SIMPLE VIEW OF INTELLECTUAL PROPERTY RIGHTS

A. Of Rights and Rents

The image of property as a bundle of rights is a familiar one in the literature. In this image, each right in the bundle represents a facet of the relation between the rights holder and the rest of society over the use and control of a scarce resource. The right to exclude others is frequently described as the most important stick in the bundle of private property rights. The implication of this model is that such rights

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4 See, for example, Carol Rose, The Comedy of the Commons: Custom, Commerce, and Inherently Public Property, 53 U Chi L Rev 711, 711 (1986) ("The right to exclude others has often been cited as the most important characteristic of private property.").
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are valuable because they enable owners to say, as per Felix Cohen, "Keep off X unless you have my permission, which I can grant or withhold. Signed: Private citizen. Endorsed: The state." This emphasis on the exclusionary facet of property rules is nothing new. Blackstone framed private property as exclusionary rights writ large, "that sole and despotic dominion which one man claims and exercises over the external things of the world, in total exclusion of the right of any other individual in the universe." Of course, Blackstone was overstating the matter and he almost certainly knew it—but nonetheless, exclusion as the essential benchmark of the value of private property rights has become a powerful and persistent theme in the literature, so powerful that it has been referred to as the "exclusivity axiom."

When applied to intellectual property, the trope is no different. Inventors give up information to the public domain (a loss to them) in exchange for exclusive rights (compensation). On this view, inventors should be loath to surrender any more information than absolutely necessary to obtain patent protection, whereas legal rules should ensure that the protection received will be sufficient, on average, to compensate for the value of the information disclosed. The private value of a patent thus becomes framed in exclusivity terms. Discussion then proceeds as though inventors sought patents solely to gain exclusive rights to a technology, and as if they only used those rights to capture an income stream from the technology, block competitors, or gain bargaining leverage with other market actors.

On this simple view, a patent's value is determined by the rents it enables the patentee to capture (or prevent others from capturing) in the relevant product market. For example, Louis Kaplow writes that

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6 William Blackstone, 2 Commentaries on the Laws of England *2 (Chicago 1979). In all fairness to Blackstone, he did appreciate the existence of property regimes, such as riparian rights, that created limited appropriability over the subject matter of the rights. Id at *18. He also discussed at some length various legal privileges trumping property rights. Id.
7 See Carol M. Rose, Canons of Property Talk, or, Blackstone's Anxiety, 108 Yale L J 601, 630 (1998) ("Immediately after he made his sweeping and highly quotable assertion equating property with exclusive dominion, Blackstone professed anxiety about the distributional foundations of existing property rights.").
8 Id at 604.
9 See Richard A. Epstein, Intellectual Property: Old Boundaries and New Frontiers, 76 Ind L J 803, 814 (2001) ("In exchange for a limited monopoly, the inventor has to disclose enough information about the patent so as to allow other individuals to build on the disclosures.").
10 See, for example, Kimberly A. Moore, Forum Shopping in Patent Cases: Does Geographic Choice Affect Innovation?, 79 NC L Rev 889, 927–28 (2001) ("The value of a patent lies in its guarantee of exclusivity, providing the patent owner a defined property right. This value depends on the boundaries of the property right, competitors' respect for those boundaries, and the ability of the patentee to enforce them.").
11 A complete recitation of the literature modeling intellectual property in terms of rents and product markets would be impossible here. For a few of the many discussions of patents
the value of a patent "depends upon a number of factors, including the market value of the invention, the structure of the market involving the patented process or product, and the attributes of the patentee (such as marketing and production capacities) that determine its range of options within that market."12 Or, in the words of Steven Cheung, the value of a patent "must ultimately rest on some marketable product actually or potentially to be generated under its provisions."13

On this view, if an inventor knows ex ante that she will be unable to sell or license a patented invention, then she should not seek a patent. If the scope of a patent is very narrow, it is likely to have little value. If demand for the patented invention is perfectly elastic or if a market for the technology does not exist and the patentee is unable to create one, then the patent is worthless. A patentee who is unwilling or unable to enforce her property rights might as well not obtain them in the first place. Once her has been granted a patent, no sane patentee would choose to forgo her only opportunity to generate revenue from it in excess of the costs of the transaction. Rational inventors will calculate the technology's expected revenue stream ex ante and proceed accordingly. Ian Ayres and Paul Klemperer illustrate this view nicely: "The current patent system—which grants the patentee a monopoly for a limited number of years—... allows the patentee to capture a rough and limited proxy of consumer value and then lets the potential innovator decide whether the benefits of innovation justify the costs."14


12 Kaplow, 97 Harv L Rev at 1823 (cited in note 11).
What, precisely, is that "rough and limited proxy of consumer value" that legal rules ostensibly enable patentees to capture? As Kenneth Dam describes it, "The economic rent received by the patentee is, in the normal case, measured by the difference between the patentee's per-unit costs and competitors' per-unit costs (to the extent attributable to the patented innovation) multiplied by the patentee's volume."  

Under the simple view, agents seek property rights to their inventions because legal rules create scarcity in otherwise inappropriable and nonrivalrous public goods. As a result of the public goods nature of knowledge, elucidated by Kenneth Arrow in his classic theoretical probe of market allocation of information, production and disclosure of inventions in the absence of legal rules creates positive externalities not capturable by the original information-producer. By creating scarcity, legal rules allow for appropriability of information, thus allowing inventors to internalize the positive externalities generated by the information they release to the world.


15 Dam, 23 J Legal Stud at 250 (cited in note 11). Schankerman and Pakes describe the present (private) value of a single patent more formally as

\[ V = \sum_{i=1}^{T^*} (R_t - C_t)(1 + i)^t \]

where \( R_t - C_t \) is the net revenue from holding the patent for time period \( t \), \( i \) is the discount rate, and \( T^* \) is the optimal patent term. \( R_t \) can be redefined as \( R_t(1 - \delta) \), where \( \delta \) is the appropriate decay rate. Mark Schankerman and Ariel Pakes, Estimates of the Value of Patent Rights in European Countries During the Post-1950 Period, 96 Econ J 1052, 1066 (1986). While such a model is more useful than the norm in that it does not assume a zero-transaction-cost world and factors in technological obsolescence, it nonetheless fails to contemplate that the value of a patent might include any variables other than those generated by product markets.

16 This theory has been described exhaustively elsewhere and need only be recited briefly here. See Arrow, Economic Welfare at 609 (cited in note 11) (examining the extent to which perfect competition leads to optimal allocation of resources). See also Lemley, 75 Tex L Rev at 993-1000 (cited in note 11) (examining how the incentives of intellectual property law encourage the production of public goods like information); Scherer, Industrial Market Structure at 379-99 (cited in note 11); Nordhaus, Invention, Growth, and Welfare at 70-90 (cited in note 11) (discussing the failure of a price system to generate new knowledge efficiently).

17 The existence and economic consequences of spillovers are well documented. See, for example, Zvi Griliches, ed, R&D and Productivity: The Econometric Evidence 251-65 (Chicago 1998); Adam B. Jaffe, et al, Geographic Localization of Knowledge Spillovers as Evidenced by Patent Citations, 108 Q J Econ 577, 577 (1993); Adam B. Jaffe, Technological Opportunity and Spillovers of R&D: Evidence from Firms' Patents, Profits, and Market Value, 76 Am Econ Rev 984, 984 (1986).

18 See Arrow, Economic Welfare at 615 (cited in note 11) ("[T]here is a fundamental paradox in the . . . demand for information; its value for the purchaser is not known until he has the information, but then he has in effect acquired it without cost."); Richard R. Nelson, The Simple Economics of Basic Scientific Research, 67 J Polit Econ 297, 300 (1959) (analyzing how private market incentives affect the direction of research). See also Nordhaus, Invention, Growth, and Welfare at 51-55 (cited in note 11) (measuring the significance of externalities in the production of knowledge); Harold Demsetz, Toward a Theory of Property Rights, 57 Am Econ Rev Papers & Proceedings 347, 348 (1967) (defining externalities).
The result is that without legal protection, not enough information will be produced; but with legal protection, not enough information will be used. By redistributing consumer surplus to producers, patents are one mechanism by which legal rules create appropriability.

The simple view of patent rights is pervasive. In fact, it is difficult to find a model or theory that describes the private benefits of patents as based on anything other than the capture of rents in the relevant product market for the technology or an improvement on the technology.\textsuperscript{20} "Defensive patenting" models, which hypothesize that firms may obtain patents in order to raise costs for competitors, still treat the value of a patent as stemming solely from rents and product markets. When Robert Merges states that "one-to-one mapping" between patent rights and markets does not always exist—or, in other words, that a technology may be protected by many patents and even by a collection of patents, copyrights, and trademarks, no single one of which covers the entire technology—he is still speaking in terms of the relationship between intellectual property rights, rents, and product

\textsuperscript{19} See Dam, 23 J Legal Stud at 261 (cited in note 11) ("Economic rent is the price paid by the patent system to deal with the appropriability problem.").

\textsuperscript{20} Theories that consider the value of patents as defensive mechanisms also rely on the capture of rents (in this case, raising the cost to competitors of capturing rents or preventing capture outright) in the relevant market based on the patented technology. See, for example, Bronwyn H. Hall and Rosemarie Ham Ziedonis, The Patent Paradox Revisited: An Empirical Study of Patenting in the U.S. Semiconductor Industry, 1979-95, 32 RAND J Econ 101, 125 (2001). In a strong form of the simple view, exclusionary rights and market power are conflated. Some courts and commentators have gone so far as to assume that intellectual property rights automatically confer market power. See, for example, Jefferson Parish Hospital District No 2 v Hyde, 466 US 2, 16 (1984) (stating that "it is fair to presume" a patent gives the patentee market power); United States v Loew's, Inc, 371 US 38, 45 (1962) ("The requisite [market] power is presumed when the tying product is patented or copyrighted."); Digidyne Corp v Data General Corp, 734 F2d 1336, 1344 (9th Cir 1984) (holding that a copyright "created a presumption of economic power sufficient to render the tying arrangement illegal per se"). Legal rules in the form of intellectual property rights usually do not confer market power in the economically relevant product market. See Phillip Areeda and Louis Kaplow, Antitrust Analysis 441-42 (Little, Brown 4th ed 1988); Herbert Hovenkamp, Economics and Federal Antitrust Law § 8.3 at 219-20 (West Lawyer's ed 1985). Nonetheless, the argument goes, the patent system seeks to grant market power. See Kaplow, 97 Harv L Rev at 1817 (cited in note 11) ("[T]he very purpose of a patent grant is to reward the patentee by limiting competition, in full recognition that monopolistic evils are the price society will pay."). Many commentators recognize, however, that not all patents confer market power. See, for example, Merges, 53 Vand L Rev at 1859 (cited in note 11) (noting the complex relationship between patents and market power); Lemley, 75 Tex L Rev at 1000-08 (cited in note 11) (illustrating the small number of patents that are litigated or licensed). The error of the strong form in assuming that patents confer market power has been discussed elsewhere. See Edmund W. Kitch, Elementary and Persistent Errors in the Economic Analysis of Intellectual Property, 53 Vand L Rev 1727, 1729 (2000) (criticizing the assumption that intellectual property rights confer an economic monopoly); Edmund W. Kitch, Patents: Monopolies or Property Rights?, 8 Rsrch in L & Econ 31, 33 (1986) ("It is not clear that every owner of a patent has a monopoly."); F.M. Scherer, Comment on Edmund Kitch, 8 Rsrch in L & Econ 51, 51 (1986) (same). It is a different but equally fundamental oversight that I am interested in exposing in this Article.
markets. Even challengers of the patent system assume that the private value of a patent is based solely on exclusive rights and rents to be captured in product markets.

B. The Implications of the Simple View

The simple view of patent rights has several implications. Under Kenneth Arrow's classic formulation, control over the invention, or "appropriability" as he calls it, drives the demand function for patents. Arrovian inventors simply would not invent (or would keep their inventions secret) in the absence of legal rules allowing the capture of rents. It is the marginal agent who invents in the absence of appropriability. If patents were suddenly found to be a poor means of capturing rents in a particular industry, we would expect the demand for patents in that industry to decrease.

On the basis of the simple view, a substantial literature has grown up that deals with the theoretical economics of patenting. Much of this literature concludes that even in the presence of legal rules, inventors will be under- rather than over-rewarded. This should not be confused with the question of whether legal rules will under- or over-induce inventive attempts. I want to focus on the private value of intellectual property and abstract away, at least for now, from the social costs and benefits of the intellectual property system.

21 Merges, 53 Vand L Rev at 1859 (cited in note 11).
23 Arrow, *Economic Welfare* at 615 (cited in note 11) ("With suitable legal measures, information may become an appropriable commodity.").
24 See, for example, Arrow, *Economic Welfare* at 617 (cited in note 11) (stating that appropriability of information is incomplete); Nelson, 67 J Polit Econ at 297 (cited in note 18) (arguing that insufficient resources are being allocated to research). For a somewhat critical view of Arrow's analysis, see Harold Demsetz, *Information and Efficiency: Another Viewpoint*, 12 J L & Econ 1, 1 (1969). For an opposing view, see Jack Hirshleifer, *The Private and Social Value of Information and the Reward to Inventive Activity*, 61 Am Econ Rev 561, 571 (1971) (arguing that overcompensation is possible).
26 Oh well, I can't resist. To the extent that the inducements of the patent system stimulate discovery of valuable new inventions that otherwise would have been developed more slowly or not at all, they increase social welfare. Of course, the social welfare benefits of inventive activity must be offset against their social costs. The social costs of the patent system go beyond the di-
The literature proposes two reasons for why the patent system consistently under-rewards inventors. First, appropriability will be incomplete and thus, even with patent protection, inventors will be able to capture only some fraction of the benefits of their discoveries. Per-
fct delineation and enforcement of rights will be impossible, and in-
ventors will be unable to appropriate the value of spillovers of their
ideas to other researchers. Even after inventors have obtained patents,
it is difficult to determine where the boundaries of the patents lie.
Measuring the attributes of patents can present high costs. Patents are
better at preventing duplication of the invention than securing royalty
income, an indication that the costs of evaluating a patent’s attributes
rect costs of R&D and deadweight loss. For example, some research might be duplicative, re-
search efforts may be diverted away from socially beneficial but unpatentable research, second-
comers may be forced to invent around existing patents, or the rents capturable from legal rules
might be dissipated in the race to capture them. See, for example, Brian D. Wright, *The Econom-
ics of Invention Incentives: Patents, Prizes, and Research Contracts*, 73 Am Econ Rev 691, 691–95
(1983) (discussing the “common pool” problem); Partha Dasgupta and Joseph Stiglitz, *Industrial
Structure and the Nature of Innovative Activity*, 90 Econ J 266, 289 (1980) (noting the problem of
duplicative invention); Glenn C. Loury, *Market Structure and Innovation*, 93 Q J Econ 395, 407
(1979) (noting the problem of too many competitors); Barzel, 50 Rev Econ & Stat at 352 (cited
in note 25) (explaining patent races and rent dissipation); McGee, 9 J L & Econ at 137 (cited in
note 11) (discussing the diversion of research efforts into patentable fields); Dan Usher, *The Wel-
fare Economics of Invention*, 31 Economica 279, 286 (1964) (discussing community decisions in
formulating incentives). Considerable attention has been devoted in the public choice literature
to the question of whether anticipated rents are totally dissipated by expenditures to capture
them. See, for example, Gordon Tullock, *Efficient Rent Seeking*, in Robert D. Tollison and Roger
D. Congleton, eds, *The Economic Analysis of Rent Seeking* 131 (Edward Elgar 1995). In the pat-
ent context, many commentators assume private actors are risk averse. Arrow, *Economic Welfare
at 610–14 (cited in note 11). If rent-seekers are not risk-neutral, or if they are in asymmetric posi-
tions, or if rent seeking is not free, the total amount expended on rent-seeking may be either
more or less than the total rent. Dennis C. Mueller, *Public Choice II* 232 (Cambridge 1989). But,
as I demonstrate later in this Article, patents can impose social costs independent of deadweight
loss. I abstract away from the merits of transferring wealth from consumers to inventors.

27 Some commentators have theorized the opposite—that the existence of multiple profit-
able uses for the same information may sufficiently reward inventors, even in the absence of
property rules. See, for example, Edmund W. Kitch, *The Law and Economics of Rights in Valu-
able Information*, 9 J Legal Stud 683, 717–19 (1980); Harold Demsetz, *The Private Production
of Public Goods*, 13 J L & Econ 293, 306 (1970). For example, Jack Hirshleifer has proposed that
even in the absence of private property rights, inventors may receive adequate compensation for
putting the information surrounding the invention in the public domain if they could speculate
on price revaluations. Hirshleifer, 61 Am Econ Rev at 571 (cited in note 24). Hirshleifer posits
that if Eli Whitney had speculated on the increased demand for cotton that his invention
spurred, he could potentially have received much greater monetary rewards than he did under
his largely unsuccessful attempts to enforce his patent. Id at 570–71.

28 See Richard A. Epstein, *Property Rights in eDNA Sequences: A New Resident for the
Public Domain*, 3 U Chi Roundtable 575, 576 (1996) ("[U]nfortunately, it is much more difficult
to define the scope of a patent than the boundaries of a parcel of land, the confines of a piece
of wood, or the body of a fox."). See also Wesley M. Cohen, Richard R. Nelson, and John P. Walsh,
*Protecting Their Intellectual Assets: Appropriability Conditions and Why U.S. Manufacturing
Firms Patent (Or Not)* *14–15, Working Paper No 7552 (NBER 2000), available online at
<http://papers.nber.org/papers/W7552> (visited Mar 26, 2002) (noting survey data indicating the
ease of investing around is the most common reason not to patent).
Patent Signals may be higher in some contexts than others. I will return to the significance of the evaluation cost of patents later in this Article. For now, it is important to note that not all attributes of a patent will be readily measurable. The difficulty of delineating the rights will decrease the effectiveness of the patent as a means of excluding others and capturing rents. Second, inventors cannot capture total consumer surplus. Although in theory the deadweight loss associated with exclusivity can be avoided by price discrimination, in practice the transaction costs of price discrimination are likely to be high.

Exclusivity unquestionably is an important aspect of private property rights. Nonetheless, a view that defines the value of patent rights solely in terms of the use and control of resources rests on an impoverished understanding of the role patents can play. Recall that traditional models of intellectual property rights frame patents as an exchange of information for protection. A critical assumption underlies this view. Inventors are assumed to suffer losses when information is made public, a loss exclusive rights attempt to compensate. If, however, we relax this assumption—either by exploring the hypothesis that inventors may in some circumstances benefit from publicizing the information surrounding the invention, or by asking whether compensation may include factors in addition to a grant of exclusive rights—then a more accurate understanding of the function of patents emerges. If inventors might gain from publicizing information in a patent, then they may choose to seek patent protection, even if the anticipated value of the exclusive rights received in return were zero. Similarly, if the grant of a patent confers benefits on patentees in addition to exclusive rights, then rational actors might seek patents in order to capture this other, non-product market benefit. Finally, if the private value of a patent includes variables in addition to those considered by the simple view, then we need to reconsider the simple view’s implication that legal rules tend to under-reward invention because appropriability is imperfect. Perhaps instead inventors may be adequately or even super-rewarded for publicizing information in a patent document, even if the exclusionary rights granted are limited.

31 See note 1 and accompanying text.
II. TRANSCENDING THE SIMPLE VIEW

In this Part, I present a new general framework by which to analyze the function and effect of patent rules. Rather than conceptualizing patent law as a set of legal rules that allows individuals to privatize what would otherwise be dissipated in the public domain, I will instead consider patents as a means of credibly publicizing information. In the balance of this Article, I will explore the hypothesis that firms may obtain patents for reasons other than capturing rents in product markets. Specifically, I will consider that patents may serve as a means of reducing informational asymmetries between patentees and observers.

Recall that the simple view treats patent protection as an exchange of information for protection. On this view, rational actors should be loath to surrender information about their inventions without receiving the corresponding benefit of exclusionary rights. Let us relax this assumption. *Pace* the simple view, let us explore the hypothesis that the patentee may desire information disclosure, even if the value of the exclusive rights (protection) obtained in exchange is zero. This could occur if information disclosure generates its own benefits, or if part of the private value of patents comes from sources other than rents captured in product markets.

The information that observers can glean from a patent or portfolio of patents can be analyzed along several margins. By obtaining a patent, firms can credibly convey information about the invention to observers who otherwise might not be willing to expend the costs necessary to obtain the information. (Because more than 80 percent of the patents granted in the United States are assigned to corporations, I will speak of patentees and firms interchangeably. 2) Patents are readily available public documents that present low acquisition costs for observers. 3 Based on the information contained in the patent, observers may conclude that the invention will increase the expected value of the firm—even if it is not the existence of patent protection that makes the invention valuable—and invest accordingly. 33 Because

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34 For example, competitive advantages may be due to non-patent factors regarding the invention, such as being a first-mover in the industry. If an invention will quickly become obsolete and will be expensive to produce in commercially viable quantities, copying may not be worth-
the penalties for intentionally misrepresenting material information in a patent are severe, observers know that the information contained in a patent has some credibility.\textsuperscript{35}

In addition to informing observers about the invention, patents can inform observers about attributes of the patentee. If patents are correlated with less readily observable firm characteristics, patents can serve as a signal of firm quality. By acting as a signal, possession of intellectual property may reduce the cost of communicating private information to the market regarding the financial prospects of the firm. If observers in capital markets believe that patents convey significant information about a firm that makes the firm a more attractive investment opportunity, firms may choose to experience losses in product markets in order to capture gains in capital markets. By conveying information to observers in a controlled and credible way, patents can have positive private value to firms, even if the exclusive rights conveyed by the patent cost more to obtain than they enable the patentee to capture in product market rents.

I want to make clear at the outset what I am \textit{not} arguing. First, I am not arguing that the right to exclude is not a valuable stick in the proverbial bundle of intellectual property rights. Rather, I contend that focusing on exclusivity and measuring value in terms of rents and product markets presents an incomplete picture of the value and function of patents. Second, I do not maintain that conceptualizing patents as an exchange of information for protection is unhelpful. Instead, it is just one way to think about the patent system. Because the simple view relies on the assumption that disclosing information represents a loss to the patentee, however, it fails to contemplate that patentees might actually benefit from the information disclosure, even if they were to receive no protection in return.

To explore the value of patents as informational mechanisms, consider a firm that has an invention. The firm must decide whether to seek patent protection, rely on trade secret protection, or forgo intellectual property protection altogether on the bundle of information. The theory underlying trade secret protection is that an information holder is allowed to keep secret the information it has acquired.\textsuperscript{36} Because patent protection requires complete disclosure of the informa-

\textsuperscript{35} See text accompanying notes 64–70 for a discussion of the verification costs of a patent and the penalties for material misrepresentations made by patentees.

\textsuperscript{36} See Restatement (Third) of Unfair Competition § 39 comment a (1995) ("Liability for the appropriation of a trade secret thus rests on a breach of confidence or other wrongful conduct in acquiring, using, or disclosing secret information.").
tion surrounding the invention, whereas trade secret protection mandates the opposite, obtaining patent protection will preclude reliance on trade secret protection. Treating the invention as a trade secret will quickly preclude patent protection. Forgoing intellectual property protection altogether will quickly become an irrevocable decision, thereby permanently barring both patent and trade secret protection. We would predict, under an economic approach to property rights, that the firm would seek and refine intellectual property rights to the invention only when they are cost effective, and that the process of defining and enforcing property rights will proceed up to the point at which marginal benefit equals marginal cost. Thus, when determining whether to obtain, define, and enforce patent or trade secret rights, the firm should examine whether the expected benefits of each regime exceed the expected costs.

The value of a trade secret, $V$, is the expected product market rents over the lifetime of the trade secret, $r$, that would not be captured but for the fact that the information has been kept secret; plus the value of the undisclosed information itself, $u$; minus the costs, $c'$, of obtaining ($c_o'$), defining ($c_d'$), and enforcing ($c_e'$) the rights in a trade secret regime. $u$ and $r'$ are two different variables because keeping the information comprising the invention undisclosed may have benefits (such as competitive advantages) separable from the rents to be derived from the invention itself. The value of a trade secret can thus be represented as:

\[
V' = r' + u - (c_o' + c_d' + c_e').
\]

Expected rents include not just the profits that would not be garnered but for the fact that the information has been kept undisclosed,

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37 Under 35 USC § 102(b) (1994), inventors must either file for patent protection within a year of publicly using the invention or forgo patent protection altogether. Thus, if an inventor treats his or her invention as a trade secret for more than one year before filing a patent application, he or she will be precluded from obtaining patent protection. See, for example, *D.L. Auld Co v Chroma Graphics Corp*, 714 F2d 1144, 1148 (Fed Cir 1983) (finding that the sale of a product whose method was kept secret barred the inventor from patenting the method after one year). Even secret use of an invention by an inventor counts as "public use" against the inventor for purposes of § 102(b). See, for example, *Metallizing Engineering Co v Kenyon Bearing & Auto Parts Co*, 153 F2d 516, 520 (2d Cir 1946) (finding that the use of a product to gain competitive advantage qualified as public use).

38 A firm that fails to treat its invention as a trade secret cannot later claim trade secret protection for that invention. See Uniform Trade Secrets Act § 1(4), 14 ULA 438 (1990) (definition of a trade secret).

but also licensing revenues from selling or licensing the trade secret.\(^{40}\) Trade secret holders are protected only against misappropriation of the information by others, but not against independent discovery or reverse-engineering.\(^{41}\) Because trade secret protection does not involve a grant of rights by the state, the cost of obtaining trade secret rights is zero.\(^{42}\) The costs of obtaining or transferring trade secret rights will be positive when the original trade secret holder licenses or sells it to another. Although the costs of defining and enforcing trade secret protection are often treated in the literature as if they were zero, such costs are positive because the information holder must take affirmative steps to determine what information comprises the trade secret and keep that information secret. For the sake of simplicity, however, I will assume that the costs of defining and enforcing trade secret protection are zero.\(^{43}\) Thus (1) simplifies to:

\[
V' = r' + u.\]

Let us now consider the value of patent protection. Under the simple view, the value of a patent is the expected rents over the lifetime of the patent, \(r^p\), that would not be captured but for the existence of patent rights, minus the costs, \(c^p\), of obtaining \((c_o^p)\), defining \((c_d^p)\), and enforcing \((c_e^p)\) the rights in a patent regime, minus the opportunity costs of making the information public (that is, forgoing trade secret protection). Extrapolating from (2), this can be represented as:

\[
V^p = r^p - (c_o^p + c_d^p + c_e^p) - r' - u.\]

I am including in my definition of \(r^p\) not just "but-for" profits, but also licensing revenues and the benefits of using the patent as a defensive mechanism against competitors. The costs of defining and enforcing patent rights will be positive, as will the costs of obtaining the rights—in contrast to a trade secret regime.\(^{44}\)

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\(^{40}\) A trade secret holder may license the trade secret and still retain trade secret protection, so long as the trade secret holder requires the licensee to continue to treat the information as a trade secret. See Restatement (Third) of Unfair Competition § 41.

\(^{41}\) *Kewanee Oil Co v Bicron Corp*, 416 US 470, 476 (6th Cir 1974) ("A trade secret law ... does not offer protection against discovery by fair and honest means.").

\(^{42}\) I do not include the R&D costs of deriving the trade secret in the costs of obtaining trade secret rights.

\(^{43}\) Even if I assumed the costs of trade secret protection were positive, the outcome would not change. If anything, the theme of this article—that patents can be valuable because they lower information costs—is reinforced by positive trade secret costs.

\(^{44}\) Conservative estimates peg the administrative costs of obtaining an average U.S. patent at $20,000. See, for example, Lemley, 95 Nw U L Rev at 1498–99 (cited in note 2) (estimating $20,000 as a "conservative average" cost of prosecution costs); Mark A. Lemley, *Reconceiving Patents in the Age of Venture Capital*, 4 J Small & Emerging Bus L 157, 138 n 3 (2000) (estimating
Now suppose patenting the firm’s invention is “worthless” or at least less valuable (under the simple view) than trade secret protection, that is, when $V^p \leq 0$ or $V^p < V$. Put another way, suppose the expected rents attributable to patent protection are less than the costs of obtaining, defining, and enforcing those rights, plus the costs $r'$ and $u$ of making the information public, such that

\[ r^p < c' + r' + u. \]

The expected costs, $c' + r' + u$ (remember, we are still under the simple view), could exceed the expected rents $r^p$ for any number of reasons. Perhaps even with the patentee’s best efforts to draft the document as clearly as possible, considerable costs would have to be incurred to define and enforce the boundaries of the patent, in which case $c'$ is large. It might be that any patent issued on the invention would be exceptionally narrow because the field is crowded and thus $r^p$ is small. Or technology might become obsolete so quickly that the firm would not find it worthwhile to defend the patent if it were infringed. Focusing on factors that influence $r'$, suppose that competitors would not copy the invention even if it were unprotected. Perhaps this is because copying the invention is costly. Empirical studies have found that the sheer cost of copying an invention—rather than protection conferred by legal rules—serves as one of the greatest deterrents to copying.\(^{41}\) Eighty-five percent of the industries surveyed in empirical studies stated that the costs of imitating an unprotected invention were more than half the original innovator’s costs.\(^{46}\) Copying may be costly because by the time copyists can retool their production lines, the invention will be obsolete. Or the invention may be difficult to reverse-engineer, in which case $u$ is large. If the invention is expensive to produce in commercially viable quantities even in the absence of legal protection, competitors may be deterred from copying. Finally,

\(^{41}\) Levin, et al, 3 Brookings Papers on Econ Activity at 809 (cited in note 29) (illustrating how patents raise imitation costs for products and processes).

\(^{46}\) Id (stating that 109 out of 127 industries surveyed, or 85.8 percent, calculated the cost of duplicating a “major unpatented new product” in the industry as more than 50 percent of the innovator’s development cost; when the innovation was a “major unpatented new process,” that number rose to 112 out of 127 industries, or 88.2 percent).
competitors may forgo copying if competitive advantages in the industry are due to non-patent factors such as being a first mover.

Would a firm ever seek patent protection under such circumstances? Under the simple view, we would expect rational actors to choose trade secret protection or no protection. It appears that under these conditions obtaining (not to mention defining and enforcing) patent rights presents positive costs but few offsetting benefits. Even if the costs of patent rights in (4) were zero, trade secret protection would still seem a better option than patent protection. If the product market rents to be obtained under either regime were equal, a trade secret regime would appear preferable so long as keeping the information secret would yield competitive advantages (that is, when \( u \) is positive). Finally, if an invention would capture the same rents whether it was protected by a patent or left unprotected, then—at least under the simple view—what would be the point of patent protection? Similarly, if the expected but-for rents under a patent or trade secret regime were zero, why bother to seek protection under any set of legal rules? What additional benefits does a firm get from obtaining intellectual property rights at all? Under these circumstances, on the simple view, we would expect rational actors to forgo protection.

If, however, the value of a patent is composed of additional variables that the simple view does not consider, then it may be rational to seek patent rights even when the expected cost of the rights is greater than the expected but-for rents. Let us consider the ability of patents to reduce informational asymmetries between patentees and observers as such a variable. I will call this the signaling value of a patent. (I specifically confine myself to considering ways in which patents can reduce information costs in capital markets, although they can be used to reduce information costs in other contexts as well, such as labor markets.)

If we include a patent's signaling value as a variable in the overall value of patent rights we can recast (3) as

\[ V = C + \alpha S + \beta T \]

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47 The innovation profile I have presented here is frequently used to describe advances in the semiconductor and information technology industries. See, for example, Hall and Ziedonis, 32 RAND J Econ at 102 (cited in note 20) (semiconductors).

48 When the invention is difficult to reverse-engineer, trade secret protection would indeed appear to create the greatest potential for \( s \) to be positive, where \( s \) is the expected net value to the patentee of conveying information in the patent document.

49 Patents may convey information about firms to existing or potential employees. They can also convey information about employees to employers. For example, firms frequently use patents to measure employee productivity and quality. If the number of patents an employee obtains (an easily measurable attribute) is truly correlated with employee productivity or quality (less easily measurable attributes) then patents could serve as a means of reducing information costs between employees and employers. Such incentives, however, may produce inefficient outcomes. Employees may reallocate resources away from productive activity and into patenting in an attempt to appear productive and influence the employer's opinion of their quality. The result is that the employee's attempts to influence the employer result in increased costs to the em-
where $s$ is the expected net value, to the patentee, of conveying information in the patent document. In practical terms, the signaling value to the patentee may be the extra capital it is able to raise in capital markets because of the information conveyed by the patent. I model $s$ and $u$ as separate variables because disclosing information in a patent may simultaneously present patentees with costs and benefits in different arenas. Patentees may experience losses from disclosing the information ($u$) for the traditional reasons assumed by the simple view: because the patent contains all the information necessary to reproduce the invention, competitors may now be in a position to design the next generation of products. Because the gain (loss) due to signaling occurs outside of product markets, I have assigned it a different variable.

We can now see why firms might choose to seek patents, even when we would not expect them to under the simple view. When the patent's expected signaling value is high, it may be worthwhile to seek patent protection, even if the expected but-for rents are negligible or the expected costs large. Even if $r^p$ is zero (such as when the invention will capture the same product market rents regardless of whether it is under patent protection), the expected costs, $c' + r' + u$, may be offset by $s$. This might explain why industries in which competitive advantage in product markets is often derived from being a first mover, such as semiconductors and information technology, are nonetheless among the industries in which patenting is most popular. This might also explain why small firms, which usually face greater informational asymmetries in capital markets than large firms, tend to patent more intensely than large firms, even though they tend to enforce their patents less. Finally, it could help us understand why start-ups and firms

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50 The information technology, semiconductor, and computer industries report that most patents in the field are ineffective or poorly effective at capturing rents and excluding competitors in product markets. See James Bessen and Eric Maskin, *Sequential Innovation, Patents, and Imitation* *1* n 2, Working Paper No 00-01 (MIT Dept of Econ 2000), available online at <http://www.researchoninnovation.org/patent.pdf> (visited Mar 26, 2002). See also Hall and Ziedonis, 32 RAND J Econ at 125 (cited in note 20); Levin, et al, 3 Brookings Papers on Econ Activity at 797 (cited in note 29). Still, the top ten patentees (by volume) in the U.S. in 2000 were IBM, NEC, Canon, Samsung, Lucent, Sony, Micron, Toshiba, Motorola, and Fujitsu. See *The Corporate Patent Scorecard*, Intel Prop Today 30 (July 2001).

that are not publicly traded are even more eager to patent than are established firms.2

Let us reconsider the simple view's assumption that a patent is "worthless," or at least less valuable, than trade secret protection when the but-for rents are less than the costs of obtaining the rights and making the information public. Recall that we expect firms to seek and refine patent rights up to the point at which the marginal benefit from doing so equals the marginal cost. The signaling value of a patent, in addition to but-for rents, is a variable that comprises marginal benefit. Taking the value of reducing informational asymmetries into account, patent protection becomes a net loss, or at least worth less than trade secret protection when

\[ r^p + s < c^p + r^t + u. \]

Clearly, for patent protection not to be worth seeking, the expected but-for rents and the expected signaling value must add up to less than the costs of patenting plus the opportunity costs of forgoing trade secret protection. Only when the patent signaling value of the patent is less than or equal to zero will the simple view's assumption that disclosure must harm the patentee be accurate. (Note that the signaling value of a patent is negative if observers would be inclined to think worse of a patentee based on the information conveyed by a patent than they would in the absence of the information.) Let us now consider when the signaling value of a patent or portfolio might be positive, how patents can reduce informational asymmetries between firms and observers, and what kinds of information can be conveyed through patents.

### III. PATENT SIGNALS AND INFORMATION COSTS

In this Part, I examine patents in the broader economic sense of informational mechanisms rather than in the narrow sense of a regime of legal rules attempting to create exclusive rights to inventions. Possession of a patent is a voluntary, readily observable, and verifiable attribute of a firm. 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

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deemed positive by observers. Along quantity margins, if observers correlate possession of patents with less readily measurable but nonetheless desirable attributes of the firm, then patents may be a useful means of conveying information from firms to observers. Along quality margins, because patentees implicitly warrant the truth of the statements contained in a patent, patents may have value if they are a credible way of conveying information that observers would find expensive to verify. Next, I model how obtaining patents could constitute a signal that sorts senders by type (high-quality versus low-quality). I demonstrate that there is a reasonable concept of a signaling equilibrium if patenting is an activity that high-quality senders will find easier to undertake. I show, however, that multiple equilibria are possible. Finally, I consider various factors that could render such a patent signal ambiguous, such as inaccurate signals, ill-informed signalers and observers, and incomplete information flows.

A. Patents and Information Asymmetries

In a world of perfect information, investors would be certain about the payoffs from investing in any given firm. When information is imperfect, by contrast, the value of a firm is ambiguous. Firms have many attributes that vary from one firm to another. Investors will not be privy to all of a firm's private information existing at the time they are considering investing in the firm. Measuring these qualities will be too costly to be done comprehensively. Instead, investors will measure the firm's attributes up to the point where the marginal benefit of doing so equals the marginal cost. In the presence of positive information costs, investors will find that some of the attributes of the firm are too costly to measure relative to their value. Under such conditions, investors may undervalue some firms and overvalue others. Investments that might otherwise be attractive may be forsaken because of these positive information costs. Investors have an incentive to minimize information costs.

Firms, too, have an incentive to minimize information costs. To the extent firms are undervalued as a result of investors' unwillingness to increase marginal evaluation efforts, firms will find informational imperfections costly. The strategy of firms will thus be to convey information about their positive attributes in a way that presents low acquisition and verification costs to the intended recipients. If the cost to the investors of receiving, deciphering, and verifying the information is high, we can expect that few intended recipients will bother to obtain it. The firm could remain underfunded and inefficiently priced,

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in which case it might not realize an adequate return on its research projects. Firms can therefore be expected to attempt to reduce informational asymmetries that affect the cost of capital.

It is more efficient to allocate information cost-reducing activities to firms than to investors. If firms are able to measure and convey information about their attributes, the measurement will occur exactly once. On the other hand, if investors conduct the measurement, attributes will be measured at least once; if there is more than one investor, chances are the attributes will be measured more than once. Although both investors and firms have an incentive to reduce informational asymmetries, firms are more efficient at doing so, even when firms' production costs are higher than investors' acquisition costs. It is useless for the firm to convey information if investors would have to spend too many resources deciphering it. In the words of Herbert Simon, "a wealth of information creates a poverty of attention." We can therefore expect publicly held firms to minimize information costs to the extent feasible. Similarly, start-up firms face the same sets of incentives to minimize information costs, even if they deal with a different set of investors.

One strategy firms can use to convey information about attributes that are not easily discernible is signaling. A signal in this context is just a variable with low measurement costs that observers believe is not independently distributed relative to variables presenting high measurement costs. To see why this is so, consider that at any moment, an observer (such as an investor) possesses a probability distribution, over possible values, of some variables of interest to it (such as the attributes of a firm). Let us assume that these variables remain unmeasured because measurement costs are high. The distribution of these unmeasured variables can be informed by the existence of an observed variable. This observed variable is the signal. If the observer believes that the signal and the unobserved variables are not independently distributed, the observer's distribution of the unobserved variables will change upon receipt of the signal. A signal, then, is any piece of information capable of altering an observer's probability distribution of unobserved variables. Signals, therefore, can have positive value that makes them worth acquiring and transmitting, so long as

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54 For discussions of which party in a transaction will incur measurement costs, see, for example, Roy W. Kenney and Benjamin Klein, The Economics of Block Booking, 26 J L & Econ 497, 539–40 (1983) (discussing block booking as a way of preventing consumer measurement); Yoram Barzel, Measurement Cost and the Organization of Markets, 25 J L & Econ 27, 48 (1982) (discussing measurement costs and their effects on market structure).

the signal and the unmeasured variables are not independently distributed.

Intellectual property can serve as a signal of less readily measurable attributes. For example, straight patent counts present low measurement costs to observers, and there is little doubt that capital markets believe patents to be correlated with various firm characteristics.\(^{56}\) Suppose investors prefer firms with higher R&D output to those with lower R&D output because they expect R&D output will be correlated with the future value of the firm. If investors believe the quantity of patents obtained by a firm in a time period (an easily measurable variable) is a measure of R&D output in that time period (a less easily measurable variable), then investors may take the firm's patent rate into account when attempting to extrapolate the future value of the firm.

Of course, if firms perceived that the existence of asymmetric information gave them an advantage, whether in product markets or capital markets, the firm could make the cost of acquisition of the information by a recipient high. The information would not be made public at all, or if it were, its sale price would be quite high. In the intellectual property context, when a firm chooses trade secret protection over patent protection, along some margins at least it has decided that the benefit of revealing the information (whether to capital markets or to product markets) is lower than the cost. The firm may announce that it has a trade secret, but such announcements will usually be unverifiable. To the extent such an announcement is verifiable, the verifiability is conferred by reputation. The market may respond to the high cost of the information by attempting to get it through means other than buying it, such as investigation of the firm's behavior or industrial espionage, or the market may not attempt to obtain the information at all.

What information do the alterable and unalterable aspects of a firm's patent portfolio convey? Individual patents and patent portfolios can signal many things. Individual patents can convey information directly and credibly about the invention. Patent portfolios can convey information about the lines of research a firm is conducting and how quickly the research is proceeding. The quantity and quality of the patents in the portfolio can serve as a signal of other firm attributes, as can the order in which the firm applies for the patents. A full consideration of all the information a patent could convey and all the ways it could do so is beyond the scope of this Article, but I discuss some of the ways in which patents can convey information below.

\(^{56}\) See, for example, Lemley, 95 Nw U L Rev at 1505–06 (cited in note 2) (noting that venture capitalists correlate patent applications with good company management).
1. Patents and portfolios can convey information about the invention and the firm.

In the most straightforward instance, obtaining a patent on an invention communicates information about the invention to the public at low cost. Individual patents can contain a wealth of otherwise unobtainable information about the invention and are often quite lengthy. A patent has two parts: the specification and the claims. The claims, which appear at the end, describe the scope of the invention. In the specification, which is the body of the patent document, the patentee must describe the invention in detail. This includes explaining how to make and use the invention, the best way to do so, how the invention is different from others in the field (the prior art), the problems the inventor faced, and the steps he or she took to solve them.

 Readers can often discover such tidbits as what kinds of experiments the patentee conducted in the course of testing the invention, what the experimental results were, and what complementary products (often mentioned by brand name) the patentee recommends for use with the invention. For example, Hewlett-Packard recommends Microsoft products. In the section in which the patentee describes how the invention differs from the prior art, patentees have the opportunity to criticize competing products. Sometimes they choose to do so by name and in scathing terms. Sun Microsystems, for one, is not above trashing the competition. Such information can provide a window into a firm’s R&D, indicate which of its competitors’ products it is directly competing with, and inform observers of the existence of aspects of an invention they would not otherwise know about. Because patents can serve an advertising function, they have value in addition to any protection conferred by the existence of legal rules. Even if patents conferred no protection, firms might find it desirable to obtain them as a means of credibly advertising their inventions.

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57 The first paragraph of 35 USC § 112 (1994) reads:
The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains . . . to make and use the same, and shall set forth the best mode contemplated by the inventor of carrying out his invention.

58 See David R.P. Taylor, et al, System and Method for a Communication System, U.S. Patent No 6,147,773 (Nov 14, 2000) (recommending Microsoft Windows as the operating system). Hewlett-Packard and Microsoft have been part of several industry working groups and strategic alliances over the years.

Portfolios can indicate what lines of research the firm is undertaking and what the firm does and doesn't consider valuable, outline a research trajectory that adumbrates fields the firm may be branching into next, disclose how fast the firm is proceeding within a particular area of research, and reveal other valuable dynamic information. Jerome Lemelson, for example, became quite rich anticipating managerial decisions based on a close study of firms' patents. By carefully analyzing—among other things—the succession of patents a firm or industry received over time, Lemelson would attempt to deduce the research a firm or industry would conduct next and what product lines it might create or expand into. He would then write patents directly in the path of the firm's or industry's progress and demand to be bought off.60 The strategy paid handsomely.61 Prior to Lemelson's success, firms had been concerned about not revealing trade secrets in patent applications. It came as a surprise to them to discover they had not gone nearly far enough: nobody had realized that information about aspects of the firm not directly related to the firm's inventions could be deduced from a study of patent portfolios.

If nothing else, patents may reveal information about the firm simply because they are costly. Under numerous explorations in signaling theory, parties signal positive attributes by engaging in costly behavior that parties without positive attributes would find hard to mimic.62 Just as a firm may use conspicuous consumption of advertis-

60 One of Lemelson's former attorneys, Arthur Lieberman, believes Lemelson deduced many of the inventions he claimed in his patents from reading other patents. Nicholas Varchaver, The Patent King, Fortune 203 (May 14, 2001) (quoting Lieberman as saying, "In many cases, Lemelson didn't patent inventions, . . . [he] invented patents.")

61 Lemelson's patents are estimated to reap nearly $1.5 billion per year in licensing fees. Warren Strugatch, From Two Patent Lawsuits, Many Reverberations, NY Times § 14LI at 6 (May 13, 2001).

62 See, for example, Eric A. Posner, Law and Social Norms 18–27 (Harvard 2000) (explaining how costly signals distinguish good from bad types); Robert Gertner, Robert Gibbons, and David Scharstein, Simultaneous Signalling to the Capital and Product Markets, 19 RAND J Econ 173, 173–74 (1988) (observing that dividends can serve as a signal of expected cash flows); Rama- sastry Ambarish, Kose John, and Joseph Williams, Efficient Signalling with Dividends and Investments, 42 J Fin 321, 321 (1987) (stating that willingness to pass up net present value investment opportunities in order to increase dividend payout—a costly activity—signals firm quality); Paul Asquith and David W. Mullins, Jr., Signalling with Dividends, Stock Repurchases, and Equity Issues, 15 Fin Mgmt 27, 35, 41–42 (1986) (noting that increases or decreases in dividends or an equity issue act as a signal); Sudipto Bhattacharya, Imperfect Information, Dividend Policy, and "The Bird in the Hand" Fallacy, 10 Bell J Econ 259, 260 (1979) (noting that dividends can serve as a signal of expected cash flows); Nicholas J. Gonedes, Corporate Signaling, External Accounting, and Capital Market Equilibrium: Evidence on Dividends, Income, and Extraordinary Items, 16 J Accounting Research 26, 30 (1978) (same); Hayne E. Leland and David H. Pyle, Informational Asymmetries, Financial Structure, and Financial Intermediation, 32 J Fin 371, 372 (1977) (stating that the capital structure of a firm signals information); Stephen A. Ross, The Determination of Financial Structure: The Incentive-Signalling Approach, 8 Bell J Econ 23, 25 (1977) (same); Michael Spence, Job Market Signaling, 87 Q J Econ 355, 358–59 (1973) (explaining how potential employees signal quality by engaging in costly activities such as obtaining a degree); Ross Watts,
ing as a means of conveying a message about itself, so firms may also use conspicuous consumption of patents as a means of displaying desirable qualities. At the very least, if a firm were to obtain far more or fewer patents than similarly situated firms—particularly competitors in the same industry—its conspicuousness would communicate some sort of information to the market.

2. Patents can be an effective signal of low future discount rates.

The information contained in a patent is at least minimally credible, and obtaining patents may be a signal of the firm’s willingness to invest in making credible statements, because patentees can suffer costs if the information in the patent turns out to be inaccurate. Because patentees have a duty of candor before the Patent and Trademark Office ("PTO"), patents can serve as a signal that a firm has a low future discount rate. A patentee has an incentive to make sure that the information contained in the patent document is accurate, because it can lose a patent for making misstatements to the PTO (and sometimes suffer worse punishment), even if the misstatements do not rise to the level of fraud. For example, if a patentee represents that its invention is able to perform a particular feat when it knows the invention cannot, the patentee may lose the patent upon a challenge by a third party. Sufficiently severe misstatements are treated as fraudulent conduct, the penalties for which exceed mere loss of the patent.

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64 See Baxter International, Inc v McGaw, Inc, 149 F3d 1321, 1327 (Fed Cir 1998) ("Inequitable conduct includes affirmative misrepresentations of material fact, failure to disclose material information, or submission of false material information, coupled with an intent to deceive."); Molins PLC v Textron, Inc, 48 F3d 1172, 1178 (Fed Cir 1995) ("Applicants for patents are required to prosecute patent applications in the PTO with candor, good faith, and honesty.").

65 Although I refer to "patentees," people with a duty of candor include:

- each inventor named in the application;
- each attorney or agent who prepares or prosecutes the application; and
- every other person who is substantively involved in the preparation or prosecution of the application and who is associated with the inventor, with the assignee or with anyone to whom there is an obligation to assign the application.

37 CFR § 1.56(c) (2001).

66 The patentee loses the right to enforce the patent, rather than having the patent itself declared invalid.

67 Demaco Corp v F Von Langsdorff Licensing Ltd, 851 F2d 1387, 1394 (Fed Cir 1988) ("Inequitable conduct may be held although the common law elements of fraud are absent.").

68 For example, in Walker Process Equipment, Inc v Food Machinery & Chemical Corp, 382 US 172 (1965), the patentee failed to disclose its own use of the patent prior to seeking patent protection. Id at 174. Because the patentee’s use put the invention in the public domain pursuant to 35 USC § 102 (1964), the patentee would not have been granted the patent had the PTO
exceptional cases, the patentee may be required to pay the fees of third parties who challenge the validity of the patent.\textsuperscript{69} Even if the mis-statements ultimately have nothing to do with the patentability of the invention, the patentee can still lose the patent for making material misstatements.\textsuperscript{65} Because firms know that losing a patent for making misstatements is a public and verifiable event, firms have the incentive to avoid making statements that are inaccurate and easy to detect.

By getting a patent, a firm devotes resources to warranting that the information in the patent is accurate. A firm that wants to make statements that it does not have to pay to warrant might prefer no protection at all, or trade secrets coupled with confidentiality agreements, over patents.\textsuperscript{70} A firm that wants to convey to observers that it is making honest statements about its research may choose to seek patent protection as a means of establishing the credibility of the statements.

The fact that the information contained in a patent has some credibility can have value for investors and thereby for firms, too. If a firm merely issued press releases about its research, investors could have no way of knowing if the information was credible and would discount it accordingly. If, on the other hand, a firm got a patent on its research results, investors would know that the statements made in the patent were probably credible. The patentee is not warranting that the information is accurate down to the last jot and tittle; rather, the patentee is warranting that it is not lying or misleading the public and that if any information in the patent proves inaccurate, the inaccuracies are not material. (If the information, unbeknownst to the patentee, turns out to be inaccurate, but the inaccuracy is immaterial, the patent will not be invalidated. The patentee may be required to correct the information, however, with the ensuing costs that entails.) For the cost of obtaining the patent, firms can warrant the credibility of the statements contained in the patent. A patent is tantamount to an investment by firms in reputation, the value of which can drop if the information released turns out to be inaccurate.\textsuperscript{71} Patenting inventions

\textsuperscript{69} 35 USC § 285 (1994).
\textsuperscript{70} PerSeptive Biosystems Inc v Pharmacia Biotech, Inc, 225 F3d 1315, 1329 (Fed Cir 2000) (holding that failure to disclose the full extent of collaboration between named inventors and a third party can be inequitable conduct); Ulead Systems Inc v Lex Computer & Management Corp, 130 F Supp 2d 1137, 1147 (C D Cal 2001) (finding a false claim of "small entity" status to be inequitable conduct).
\textsuperscript{71} This assumes the trade-secret-plus-confidentiality agreement costs less than getting a patent. For the cost of getting a patent, see text accompanying notes 44–46.
\textsuperscript{72} Barzel, 25 J L & Econ at 28–32 (cited in note 54) (reviewing the costs of inaccurate information); Sanford J. Grossman, The Informational Role of Warranties and Private Disclosure about Product Quality, 24 J L & Econ 461, 470–77 (1981) (stating that warranties can act as a signaling device); Benjamin Klein and Keith B. Leffler, The Role of Market Forces in Assuring

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known about the use.
can represent a credible signal of high firm value, if it is cheaper for high-value firms (in this case, firms willing to invest in honesty) to do so.

3. Market actors believe patents are correlated with various firm attributes.

A theory that patents can serve as signals is supported by evidence showing that patent counts are positively correlated with certain firm characteristics. Many observers—academics, industry analysts and investors, venture capitalists, and firms—correlate patents with desirable firm attributes and have been doing so for decades.

For instance, in the academic literature, simple patent counts have long been used as a measure of firm productivity, innovative activity, firm size, and other less readily measurable factors. Econometric models of firm productivity often create a patent production function in which patenting is a dependent variable and inventive output by the firm is an independent variable. The sheer numerosity of patents has often been considered to be a more immediate and directly measurable consequence of inventive activity than other performance indicators such as profits and product sales.

Capital markets appear to believe that patent counts correlate with other, less observable, firm characteristics not directly related to the inventions. Straight patent counts are used as a means of measur-

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Contractual Performance, 89 J Polit Econ 615, 617 (1981) (stating that the failure of firms to supply correct information leads to a drop in market position).


76 See, for example, Ariel Pakes, On Patents, R&D, and the Stock Market Rate of Return, 93 J Polit Econ 390, 390 (1985) ("The patent variable has the advantage of being a more direct consequence of inventive activity than the other indicators of performance available.").
ing otherwise unobservable or difficult-to-measure attributes, such as
trer patents as a benchmark of firm innovativeness. It is not sur-
prising that markets look to a firm’s patent portfolio as one factor that
can reveal information about the firm’s R&D expenditures. The corre-
lation between patents and R&D expenditures is positive and strong: 
changes in a firm’s R&D expenditures have a significant effect on 
changes in the firm’s rate of patenting. Patents, therefore, are (at least) a rough measure of the value of a firm’s inputs into R&D. Dy-
namically, capital markets appear to recognize this relationship and 
respond to it. Unexpected changes in the number of patents held by a 
firm—even an unexpected increase in the size of a portfolio by one patent—are associated with large changes in the market value of the 
firm. When a firm intensifies its patent rate, this often correlates with 
an increase in firm value.

In addition to serving as a means of measuring individual firm 
productivity and innovativeness, patents also appear to be a way for capital markets to benchmark firms relative to each other. Patents appear to be a fairly good indicator of differences in inventive activity 
across firms in an industry. Fluctuations in an individual firm’s patenting rate over time are indicative of inventive activity (R&D output), but have a large noise component.

Firms also seem to use patents to benchmark their performance 
relative to other firms in the industry. Firms patent more intensely 
when they perceive competitors in the same industry to be increasing 
their levels of patenting. There could be several explanations for this. Firms could begin to patent more intensely because they want to increase the strength of the legal fences around their own technology. At the same time, firms could also patent more intensely because they

77 Griliches, 28 J Econ Lit at 1673, 1684 (cited in note 74) (correlating patent counts with 
R&D expenditures, stock market value, and other indicators of economic success).
78 Hall, Griliches, and Hausman, 27 Intl Econ Rev at 281 (cited in note 75) (showing a 
strong, largely contemporaneous relationship between R&D expenditures and patenting); Pakes, 
93 J Polit Econ at 392 (cited in note 76) (“If an event does occur that causes the market to re-
evaluate the accumulated output of the firm’s research laboratories, its full effect on stock mar-
ket values ought to be recorded immediately.”).
79 Pakes, 93 J Polit Econ at 403, 406 (cited in note 76). Pakes finds that an unexpected in-
crease in one patent is associated with an $810,000 increase in the market value of the firms in 
his sample. Id. See also Griliches, Pakes, and Hall, The Value of Patents at 109 (cited in note 52).
80 Bronwyn H. Hall, Adam Jaffe, and Manuel Trajtenberg, Market Value and Patent Citations: A First Look *17, Working Paper No 7741 (NBER 2000) (“An increased yield of one pat-
ent per million dollars of R&D is associated with a two percent increase in the market value of 
the firm.”).
81 Pakes, 93 J Polit Econ at 405 (cited in note 76) (finding that 76 percent of the variance in 
the size of patent portfolios among firms in the same industry can be credited to research-related 
events that cause changes in the market value of the firm, although changes in patent rates over 
time by a single firm are not as strongly correlated with the firm’s rate of inventive output).
want to match the signal sent by their competitors. Even in industries where patent appropriability traditionally is poor, firms whose close competitors engage in more (observable) R&D tend to obtain more patents per R&D dollar.\footnote{This study controls for technological opportunities. Adam B. Jaffe, \textit{Technological Opportunity and Spillovers of R&D: Evidence from Firms' Patents, Profits, and Market Value}, 76 Am Econ Rev 984, 998 (1986) (concluding that “firms whose research is in areas where there is much research by other firms have, on average, more patents per dollar of R&D”).} Firms that fail to keep up with their competitors in the patent race experience lower market values.\footnote{See id at 998 (“[F]irms with very low R&D suffer lower profits and market value if their neighbors are R&D intensive.”).}

Patents appear to play a particularly valuable signaling role in the start-up phase of a firm’s life. Among venture capitalists, both the quantity and quality of patents have long been factors that are taken into consideration when deciding whether to invest in a company, particularly in its early stages.\footnote{See David L. Hayes, \textit{What the General Intellectual Property Practitioner Should Know about Patenting Business Methods}, 16 Computer Lawyer 3, 4 (Oct 1999) (“Patent protection is increasingly a factor that investors such as venture capitalists consider in deciding whether to invest in a company, especially in its early stages.”).} This may explain why start-ups are even more eager to obtain patents than are established firms.\footnote{General Georges Doriot, the founder of the first venture capital firm, American Research & Development, and a man often considered the single most significant figure in post-World War II venture capital, used intellectual property protection as one of the factors in his investment decisions. See Joseph W. Bartlett, \textit{Fundamentals of Venture Capital} 3 (Madison Books 1999).} Indeed, venture capitalists have treated ownership of intellectual property as a positive factor in the decision to invest since the modern venture capital era began in 1946.\footnote{Hall and Ziedonis, 32 RAND J Econ at 104 (cited in note 20). See also Griliches, Pakes, and Hall, \textit{The Value of Patents} at 100 (cited in note 52); Mansfield, 32 Mgmt Sci at 177 (cited in note 52).} As Mark Lemley puts it, “Venture capitalists use client patents (or more likely, patent applications) as evidence that the company is well managed, is at a certain stage in development, and has defined and carved out a market niche.”\footnote{Lemley, 95 NW U L Rev at 1505–06 (cited in note 2). See also Samuel Kortum and Josh Lerner, \textit{Assessing the Contribution of Venture Capital to Innovation}, 31 RAND J Econ 674, 689 (2000) (suggesting “a strong relationship between venture capital [funding] and patenting”).} According to Lemley, venture capitalists will even evaluate start-ups on the basis of patent applications if the patents have not yet issued. Bronwyn Hall and Rosemarie Ziedonis find that for recent market entrants in the semiconductor industry, one of the primary roles for patents “appeared to be in securing capital from private investors in the startup phase.”\footnote{Hall and Ziedonis, 32 RAND J Econ at 110 (cited in note 20).}
ability of the firm to vary output along quality margins, and ignores inefficiencies generated by duplication of effort, waste, opportunity costs, and transaction costs. Knowledge production is lumpy, so patents will contain information in varying amounts and qualities. Patents are by definition heterogeneous. Measurement of the attributes of individual patents is costly, and the scope and quality of the protection conferred upon the underlying invention is variable from patent to patent. Second, even if quality is held constant, the propensity to patent an invention may vary among firms and among industries. Patents do not represent all of the output of R&D. Industries vary significantly in the average number of patents generated by each dollar invested in R&D. The noise in the relationship between patent counts and the value of the underlying inventions (and by implication, the firm) makes it difficult to use patent counts as a robust measure of firm value. These observations do not negate the value of patents as a means of conveying information about the firm; rather, they indicate that patents are a noisy signal.

Ultimately, patents can be interpreted as signaling many things in capital markets. Whatever attributes of the firm patents are believed to correlate with, the signaled characteristics are generally considered positive. More patents equal more money being spent on R&D; more patents indicate firm confidence in its research. More patents mean the firm is willing to increase the amount of money it loses if it makes false statements about its research. Nobody decides that a firm is a bad investment on the grounds that it has the largest patent portfolio in the industry. Nobody associates obtaining patents with sloth and shiftlessness.

My hypothesis that patents serve a signaling function does not deny the role of the patent system as a means of encouraging innovation by granting exclusive rights to inventors. Rather, the signaling function of patents is part of the larger view about the nature of property rights to information and the efficiency concerns surrounding those rights. It is based on the assumption that many attributes of the

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91 Observers' perception of patents can sometimes be negative. On occasion, firms may choose to forgo obtaining or enforcing patent rights in order to signal that they are "good types." See, for example, Melody Petersen and Donald G. MacNeil, Jr., Maker Yielding Patent in Africa for AIDS Drug, NY Times A1 (Mar 15, 2001) (describing how Bristol-Myers Squibb was praised when it announced its decision not to enforce its patent on the AIDS treatment d4T in Africa).
firm are hard to measure. Investors have good statistical information across the market (or industry) but not with respect to the research projects of individual firms.

B. A Patent Signaling Model

If patents serve as an accurate signal, then observers will be able to distinguish high-quality firms from low-quality firms on the basis of the firm's patent portfolio. Given that capital markets use a firm's patent portfolio as one means of measuring other more opaque firm attributes, however, firms have the incentive to manipulate this public, measurable, and voluntary attribute. If patents are a signal that is too easy for low-quality firms to send, then observers may believe patent portfolios correlate with firm quality when they really do not.

Below, I present a model of patent signaling. I also explore whether there are multiple equilibria in this model, and how many there might be. The basic insights in this model recur in the application of signaling to such issues as capital structure, dividend policy, advertising, education, insurance, and social norms.  

Consider a world in which investors divide firms conducting research into two types:9 innovative and boring. Innovative firms (I) have a portfolio of research projects that managers believe will have a high expected payoff on average; boring firms (B) have a portfolio of research projects that they believe will have low expected payoffs. Assume the payoff will not be attributable to the possession of patent rights. For example, assume that both types of firms expect that patents will confer no appropriability because nobody in the industry bothers to enforce them. By the time a competitor copies the patented product and builds production facilities, the technology covered by the patent has become obsolete. Knowing this ex ante, competitors will not copy. Note that this does not mean that appropriability per se is zero, just that it is not the presence of legal rules that deters copying. Innovative firms believe that the products generated by the research are of high quality and that first-mover advantages (not patents) will allow them to reap profits.

Assume that firms know their type and that investors are risk neutral. If there is symmetric information as to firm type, investors will know whether they are investing in innovative or boring firms. Under

92 I have adapted this model from the one presented by Ross, 8 Bell J Econ at 25–32 (cited in note 62). Ross’s model is used to demonstrate the use of the debt-equity mix by a firm to signal quality. More formal descriptions of signaling models can be found in many game theory texts. See, for example, Fudenberg and Tirole, *Game Theory* at 324–29, 446–60 (cited in note 73) (providing analyses of signaling games).

93 Quality, of course, is a continuum. While realizing that types are distributed continuously, I divide firms into two types for the convenience of my model.
these conditions, they will be willing to invest more in companies that have a portfolio of innovative research projects than those that do not. Let the expected value at some future time \( t = 1 \) of innovative firms be \( i \) and that of boring firms be \( b \). Because innovative firms are more highly valued, \( i > b \). Assume that the value of innovative and boring firms at \( t = 0 \) is determined by capital markets according to an accepted method of valuation, based on the expected future value of the firm. In the interest of simplicity I assume that the risk-free discount rate is zero. I further assume that the variance in the payoff from innovative and boring firms is the same. The value of innovative and boring firms at \( t = 0 \) is as follows:

\[
V_0' = i \quad \text{and} \quad V_0^b = b.
\]

Now suppose there is asymmetric information between firms and investors as to firm type. Investors will not be able to separate the innovative firms from the boring ones and will believe that they are investing in both types. Unable to separate innovative from boring firms, investors will treat all firms as if they were average. Innovative firms would then bear the costs of the information asymmetry. I assume that even if investors do not know the type of a specific firm, they can form a probability distribution of innovative and boring firms. If investors know the proportion of innovative firms to be \( x \) and boring firms to be \( (1 - x) \), all firms will have the same market value at \( t = 0 \). This can be represented by the equation:

\[
V_0 = xi + (1 - x)b, \quad \text{where} \quad V_0' > V_0 > V_0^b.
\]

Consequently, innovative firms will have an incentive to disclose the superior nature of their research results so that they can appear more attractive to investors. Innovative firms might simply claim to have superior research projects in order to increase their value at \( t = 0 \), but boring firms could well claim the same thing. If boring firms could send the same signals as innovative firms, the signals would not be credible because they would not allow investors to sort firms with different unobservable characteristics. Both types of firms, making identical claims, would continue to be indistinguishable and their values would not change from \( V_0 \).

\[94\] This is an example of a lemons problem, as described by George A. Akerlof, *The Market for “Lemons”: Quality, Uncertainty and the Market Mechanism*, 84 Q J Econ 488, 488 (1970) (discussing adverse selection and the use of signals to overcome it). See also Grossman, 24 J L & Econ at 462 (cited in note 72) (discussing situations in which good sellers can distinguish themselves from bad ones); Charles Wilson, *The Nature of Equilibrium in Markets with Adverse Selection*, 11 Bell J Econ 108, 130 (1980) (reviewing variable equilibrium points when restricted to
In order to make credible claims, innovative firms must engage in behaviors that impose substantial monetary or reputational costs if the signal is inaccurate.\textsuperscript{95} These costs must be so high that boring firms would find them too costly to send. As I demonstrated in Part II, obtaining patents is not a costless endeavor, so obtaining a patent portfolio could serve as a credible signal of firm quality. 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. When the cost of the signal separates out firms by type, the signal is self-enforcing.

Assume the process of obtaining a patent portfolio of specific characteristics $P$ costs boring firms more than it costs innovative firms. We can say that boring firms bear a cost $C$ and innovative firms bear a cost $\alpha C$, where $\alpha$ is some value less than unity (that is, $0 < \alpha < 1$). Note that the cost differential $\alpha$ is a crucial component of the effectiveness of patents as a signal of firm type. As I explore later in this Part, if obtaining a portfolio of patents costs boring firms as much as it costs innovative firms, such that $\alpha = 1$, then patents become ambiguous as a signal.

If investors interpret the costly behavior of obtaining a patent portfolio as a signal of firm type, then they will conclude that firms that obtain $P$ are innovative firms and those that do not are boring firms. The value of an innovative firm at $t = 0$ is:

$$V_0^I = i - \alpha C \text{ if it obtains } P, \text{ or } b \text{ if it does not,}$$

whereas the value of a boring firm at $t = 0$ is:

$$V_0^B = i - C \text{ if it obtains } P, \text{ or } b \text{ if it does not.}$$

Innovative firms desiring to maximize firm value have the incentive to seek patents, and therefore to signal accurately, if their cost ($\alpha C$) of doing so is less than the change in value an innovative firm would experience by being labeled a boring firm, which simplifies to $C < (i - b)/\alpha$. Boring firms have the incentive not to seek patents, and thereby signal accurately, if the cost of doing so is greater than the

\textsuperscript{95} For a description of self-confirming signals, see Spence, 87 Q J Econ at 360 (cited in note 62).
change in value a boring firm would experience by being labeled an innovative firm, that is, if $C > i - b$. Patents would serve as an effective signal in equilibrium if the marginal benefit to a firm of being perceived by investors as innovative rather than boring is less than the cost to a boring firm of signaling but more than the cost to an innovative firm of signaling. In other words, a separating equilibrium may exist where the signal $P$ costs more than $i - b$ and less than $(i - b)/\alpha$. In equilibrium, the signal separates the innovative and boring firms because only the innovative firms engage in the behavior the signal represents.

Note that a signal can still produce a separation between innovative and boring firms when it is not costly to send the signal but costly to send it falsely. Such signals are effective when sanctions created by legal rules, such as loss of reputation or liability, impose costs on dishonest signalers that are higher than the costs imposed on honest signalers. On this view, it does not matter what attribute is being signaled or how, so long as the fear of reputational loss serves to distinguish firms possessing the signaled attribute from those that do not. Informal ex post reputational sanctions may not be enough to produce a signaling equilibrium, in which case firms possessing the signaled attribute may seek other devices to force separation between firms possessing and not possessing the attribute. One method would be to create a legal regime that penalizes false signalers, with formal legal sanctions replacing or supplementing informal reputational sanctions. With respect to patents, some degree of formal legal sanctions exists. If a patentee is found to have misrepresented information in the patent (inequitable conduct), the patent will be invalidated ex post. At the very least, investors can be assured that firms will not make objectively false statements in the body of the patent; if they do, they will bear both actual and reputational costs. By affecting the activities of firms, legal rules can affect the way information is transferred between parties.

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96 For purposes of this Article, I assume partial equilibrium analysis: that the values of other attributes of the firm (especially goods and services) unrelated to the firm's patenting practices remain constant. To the extent they are not, that only reinforces my point that the value of a patent may depend on more than its ability to appropriate rents. On partial versus general equilibrium analysis, see generally, James M. Henderson and Richard E. Quandt, Microeconomic Theory: A Mathematical Approach (McGraw-Hill 3d ed 1980).

97 Firms could also precommit to signal honestly by posting a bond that would be lost should the signal turn out to be false. As I discuss in this Article, the patent system can be compared to a bonding device.

98 See notes 65-70 and accompanying text.
C. The Potential Ambiguity of Patent Signals

Do patents really separate firms by type? In the absence of empirical data, it is not possible to say whether the patent system creates a pooling equilibrium or a separating equilibrium in fact. I have used insights from the corporate law literature to theorize that the patent system might be able to serve as a separating mechanism under certain conditions. On the other hand, patents and portfolios may be ambiguous signals that create a pooling equilibrium. Let us consider some of the factors that can serve to muddy signals sent by the patent system.

1. Patents may fail to separate firms by type.

Patents would operate as a signal that serves to separate firms by type when there is an equilibrium in which innovative firms have the incentive to patent (or patent more) and boring firms do not, and as a result the signals are believed by investors. By contrast, a pooling equilibrium obtains when innovative and boring firms alike have the incentive to signal by obtaining patents. Investors are unable to distinguish firms by type based on their patenting activities. In my model, two pooling equilibria could occur: no firms signal, or all firms signal inefficiently. The equilibrium in which no firms signal can be further subdivided. First, signaling could prove too costly even for innovative firms (that is, $C > (i - b)/\alpha$), in which case innovative and boring firms alike do not signal. Alternatively, signaling could be too cheap: firms have the incentive not to signal if the cost is less than the difference in value between innovative and boring firms (that is, $C < i - b$), if investors know that signaling is cheap and consequently will not believe any signal, and if firms know investors' beliefs ex ante.

In the second pooling equilibrium, in which all firms signal and do so inefficiently, innovative firms lack sufficient information to foresee that they cannot reach a separating equilibrium, but firms' knowledge of investor sorting practices in turn leads to feedback effects. Innovative firms signal by obtaining patents, and boring firms emulate the signaling behavior of the innovative firms. Once both types of firms are signaling, both types fear abandoning the behavior because investors might interpret it as a sign of low firm quality. If investors come to realize that the signal is false, they will no longer be willing to invest in both types of firms even at $V_0$, because the cost of sending the signal decreases the average firm value to $V_0 - C$.

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99 See Spence, 87 Q J Econ at 356 (cited in note 62) (stating that a lack of information about prospective job applicants makes both good and bad applicants appear similar to a potential employer).
An innovative firm might prefer not to signal and rely on trade secrets instead of patents to protect the invention, if investors applied an average value \( (V_o) \) to firms that did not signal with patents. Faced with some firms obtaining patents and others not, investors will interpret the absence of a signal as evidence that the firm lacks confidence in the future profitability of its research projects. Given the choice between not obtaining patents and being labeled boring and obtaining patents and being labeled innovative, a firm with innovative projects will prefer to be accurately labeled.

The process of signaling then becomes a race between innovative firms trying to outsignal boring ones and boring firms trying to keep pace with the innovative firms' signals. Obviously, the race cannot go on forever. At some point, the marginal benefits to innovative firms of getting the \( n \)th patent will be exceeded by the marginal costs to investors of processing the additional information. When this point of investor information overload is reached, firms will seek lower-cost, more effective strategies to reduce informational asymmetries.

This signaling approach is individually rational but socially inefficient. If boring firms can falsely match the signal sent by innovative firms by obtaining patents, this imposes an externality on innovative firms. The inefficiency arises not just because boring firms spend resources falsely matching innovative firms' signals but also because innovative firms may signal excessively in an attempt to distinguish themselves from boring firms.

2. Signalers and observers could be misinformed.

Another source of ambiguity in the signal could arise if signalers and observers are not accurately informed about the circumstances surrounding the signal. For example, observers may believe that patents correlate with some firm characteristic when in fact they do not. Correlations between patents and other firm attributes, to the extent they exist, will vary depending on the characteristic in question. Or information flows may not be accurate because observers may believe the signal to have less noise than it actually does. I have already discussed how straight patent counts may be poor signals (despite the fact that they are widely used) because they are noisy. Observers, however, may believe the signal to be crisper than it really is if they overestimate the correlation between the patent signal and underlying firm quality. These inquiries raise the question of the degree to which patents convey information about the fundamentals of the firm.\(^\text{100}\)

\[^{100}\text{The market is informationally efficient when stock prices immediately reflect different categories of available information; it is fundamentally efficient when stock prices reflect the present value of firms' expected profits, given the information available. See Ian Ayres, Back to}\]
Whether patents actually correlate with fundamentals is a question far beyond the scope of this Article, and one I will leave to others to explore.

In my model, I assumed that there are two types, and that firms know their type. As I pointed out, however, in reality type is a continuum. Firms will not be divided neatly into high-quality and low-quality firms, nor will firm quality remain constant over time. Such factors increase the probability that any patent signal sent by a firm will not correlate neatly with a discrete type and thus that observers will not be accurately informed.

Even if only two types of firms existed, using patents as a mechanism to separate firms by type requires that a patentee know its type and signal honestly. Patentees may be mistaken as to type. Here, rather than attempting to signal falsely, patentees are wrong in their estimation of value.

Mistakes could arise simply because of uncertainty, biased judgment, or both. Behavioral decision theory presents us with ever-increasing evidence of cognitive biases of sundry sorts, often involving people overestimating their abilities or chances of success.\textsuperscript{101} For example, more than 88 percent of high school seniors polled believed they were above average in their ability to get along well with others.\textsuperscript{102} A survey of Silicon Valley engineers found that more than one-third of the engineers polled described their performance as placing them in the top 5 percent of the profession and nearly 90 percent thought they were in the top 25 percent, whereas less than 1 percent believed their performance to be below average.\textsuperscript{103} Nor is the bias confined to engineers. Almost 90 percent of drivers surveyed believed their driving skills were above those of the average driver.\textsuperscript{104} And academics are not immune from over-positive assessment either: 94 percent of col-

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\textsuperscript{103} Joseph Bankman and Ronald J. Gilson, \textit{Why Start-Ups?}, \textsuperscript{51 Stan L Rev 289, 291 n 3} (1999).

\textsuperscript{104} Ola Svenson, \textit{Are We All Less Risky and More Skillful than Our Fellow Drivers?}, \textit{47 Acta Psychologica} \textsuperscript{143, 146} (1981).
lege professors surveyed asserted that they were better teachers than their average colleague.\textsuperscript{105}

If individuals in myriad situations overestimate the quality of their skills and attributes, then firm managers might as well. If a manager believes his or her firm is conducting research that is of higher quality than it actually is, managers may misestimate firm type and seek to patent too much.\textsuperscript{106} Under this circumstance, patents will fail to distinguish firms that are accurately assessing their research as innovative from those that are viewing their research too optimistically. When managers overassess the future value of the research and seek to signal their confidence in the research to capital markets, the signal sent by a large patent portfolio can be ambiguous because both good and bad types are signaling. So long as the problem is firms not knowing their type because of cognitive biases, rather than adverse selection, increasing the costs of patenting will not improve the separation. If firm managers could accurately evaluate the probability distribution of returns for each research project, then the chances of the patenting signal being ambiguous would diminish.

Even if firms know their types and signal accurately and the observers appropriately discount for the noise, the informational content of patents as a signal might still be weakened. If observers believed that a firm was not likely to be a repeat player—that it was a fly-by-night operation, that it would not be in the market long—my argument that firms use their intellectual property as a means of credibly signaling otherwise difficult-to-measure qualities would carry less weight. For example, a start-up firm that was unsure of its future success might choose to obtain an "excessive" number of patents in order to impress investors. As Michael Spence points out, complications arise when players—in this case patentees and observers, but it could be any two parties to a signaling game—are aware that another player thinks of an activity as a signal.\textsuperscript{107} Alternatively, firms that are not confident in their research projects may obtain patents in order to conceal the riskiness of their activities. Signalers, therefore, must be in the market long enough that observers believe them to have the incentive to invest in credible signaling.

\textsuperscript{105} K. Patricia Cross, Not Can, But Will College Teaching Be Improved?, 17 New Directions for Higher Educ 1, 10 (1977).

\textsuperscript{106} For a general discussion of risk assessment and managerial bias, see Daniel Kahneman and Dan Lovallo, Timid Choices and Bold Forecasts: A Cognitive Perspective on Risk Taking, in Richard P. Rumelt, Dan E. Schendel, and David J. Teece, eds, Fundamental Issues in Strategy 71, 71 (Harvard Business School 1994) (arguing that "decision makers are excessively prone to treat problems as unique, neglecting both the statistics of the past and the multiple opportunities of the future").

\textsuperscript{107} Spence, 87 Q J Econ at 358–59 (cited in note 62).
3. Signals versus satisfaction of some other preferences.

Because the behavior of a firm is the outcome of multiple variables, the motives behind the behavior may be ambiguous, rendering the signaling value of the behavior noisy. One could argue that a source of ambiguity is whether a firm signals in order to convey information about attributes that are not readily measurable, or whether it does so for some other reason. Even if patentees are obtaining patents for reasons other than appropriability, they might not be doing so for reasons that have anything to do with signaling. On this argument, a firm's decision to obtain a large number of patents may be highly correlated with high firm quality, but this does not necessarily mean obtaining patents is a signaling strategy if the firm would have had the same incentives to obtain a large patent portfolio even if there were no informational asymmetries between the firm and investors. If firms are obtaining patents when many of those firms believe patents to be a poor means of appropriability, maybe they do not intend to send signals but instead are doing so for other reasons that have nothing to do with appropriability (such as gaining tax benefits).

On this view, sending a signal requires some deliberate intention on the part of the sender, whereas information that comprises an index is not generated with signaling intent. For example, the decision to obtain patents would be an index if firm managers were unaware that investors interpreted such a decision as a sign of quality. On this argument, the decision would not be an attempt to signal, regardless of what investors perceive, because firms would not be engaging in the underlying behavior (patenting) in order to convey information about the firm. In order for obtaining patents to serve as a signal, managers would have to get patents for the purpose of conveying information about the firm to the market. Managers might be motivated to get patents for any number of reasons that might or might not have to do with appropriability, but those reasons would not include signaling efficiencies. Perhaps obtaining a patent is just an observable characteris-

103 Taxpayers may deduct the costs of qualifying research activities. 26 USC § 174(a)(1) (1994) ("A taxpayer may treat research or experimental expenditures which are paid or incurred by him during the taxable year in connection with his trade or business as expenses which are not chargeable to capital account. The expenditures so treated shall be allowed as a deduction."). Qualifying expenses include the costs of obtaining a patent and the costs of developing or improving a pilot model, process, formula, invention, technique, or similar property. Treas Reg § 1.174-2(a)(1)–(2) (1999) (containing examples). Obtaining a patent may improve the chance of other expenditures on the same research project being deemed deductible. See, for example, Magee v Commissioner, 52 Tax Ct Mem Dec (CCH) 1277, 1278–80 (1973) (holding that procuring a patent was strong evidence of an expectation of economic return and thereby allowing deductions pursuant to IRC § 174 (1954) for such indirect expenditures as telephone expenses, travel costs, and labor costs incurred in invention activities).
tic of a firm that does not represent any attempt to convey information in capital markets.

Alternatively, one could argue that a behavior does not have to be deliberately sent in order to be a signal. For a particular behavior to be a signal, it is only necessary for observers to believe that it serves as a signal. On this argument, investors need only perceive a correlation between firm type and a behavior. Thus, if investors recognize that firms with large patent portfolios experience profits from their research projects, the behavior of amassing a large patent portfolio becomes a signal, whether the firms know it or not.

In addition to granting exclusionary rights, patents may also serve as a means of allowing property holders to convey information to the world. A primary function of the patent system is defining rights to ideas. But in the course of defining rights to ideas, it may generate signals of other attributes. If it is in fact the case that patents are correlated with positive firm characteristics (or positive employee characteristics in the labor market context), then the patent system produces signals about attributes that are harder to measure.

IV. IMPLICATIONS

Signaling and information costs have broad implications, both theoretical and practical, for our understanding of the private value of patents. In this Part, I consider some of these implications. First, I consider some efficiency aspects of patents as a signal. I discuss various collective and institutional mechanisms that attempt to increase the credibility of the information contained in a patent. Then I consider how firms may focus on different aspects of the patent signal. Finally, I focus on how the information value of patents can influence our understanding of the welfare effects of the patent system.

A. Some Efficiency Aspects of Patents as Signals

Recall that determining the attributes of firms has positive measurement costs. Many attributes are not readily measurable at all and even if measurable are not verifiable. Observers could attempt to determine the attributes of a firm and its research projects, but if measurement and verification are conducted without the firm’s assistance, this would be duplicative and costly. Because direct observation and measurement of a firm’s attributes are costly, observers can benefit if they use signals emitted by the firm. As I have argued, patents can serve as such a signal. If patents increase the amount of accurate information available to observers, they can reduce investors’ risk. We can expect observers to be sensitive to the
second order costs incurred in interpreting the patent signal in addition to the first order costs of measuring a firm’s attributes.

1. Verification and evaluation costs.

Investors have the incentive to verify and evaluate the information contained in the signal because firms have the incentive to signal opportunistically.109 In addition to knowing that a firm has a portfolio of a certain size or that it holds a particular patent, investors may want to determine what information the patent contains and whether the information is accurate. Firms obviously have the incentive to present positive information about their attributes.110 Recipients then must determine if the firm behaved opportunistically in disclosing the information. Firm managers may stand to benefit, at least in the short term, by having investors overvalue the firm. For example, managers may have the incentive to make misstatements in the patent in order to increase firm value. If the quality of the signal released by the firm is difficult to determine, investors will discount the information’s accuracy. Firms then will have too little incentive to provide verifiable signals, because they will be discounted to an average level of believability.111

Although they may reduce information costs, patents and portfolios present their own set of information costs. Not all the attributes of the patent signal are readily measurable. Some aspects of the signal present higher verification costs than others. A firm’s claim that it has a portfolio of five hundred patents can be easily verified; a firm’s claim that it has five hundred valid patents presents higher verification costs; and a firm’s claim that its five hundred patents are of high quality is difficult if not impossible to verify. A firm’s claim that it has patented a new scientific discovery is easy to verify along one margin (the discovery is patented), but presents higher verification costs along others (whether it is truly new or innovative).

Verifying the quantity of patents held by a firm presents low costs. Patents are made public the day they are issued. The text of a patent is readily available at the PTO’s website. If a firm asserts that it possesses a particular patent in its portfolio, or claims to have a certain number of unexpired patents in its portfolio, such statements can be

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109 See, for example, Hirshleifer, 61 Am Econ Rev at 569–70 (cited in note 24) (discussing the difficulty of valuing information). The general problem of verification costs is presented in Barzel, 25 J L & Econ at 28–32 (cited in note 54).

110 Firms could choose to disclose negative information if such disclosure would mitigate the degree to which recipients would assume it was negative. S.J. Grossman and O.D. Hart, Disclosure Laws and Takeover Bids, 35 J Fin 323, 326–27 (1980). The marginal benefit of revealing the negative information would of course have to outweigh the costs of doing so. Along the same lines, the firm might choose to reveal negative information if doing so would make positive information appear more credible.

111 The lemons problem appears again. See note 94 and accompanying text.
readily verified. Verifying anything beyond quantity presents higher costs. Observers may employ experts such as attorneys, consultants, or scientists to examine individual patents more closely. Observers must still verify the information individually, but at least such verification achieves some economies of scale and experience in analyzing the information contained in the patent.

If patenting is used as a signal of positive firm attributes, investors must correlate patents and portfolios with desirable firm qualities. Obtaining the necessary training to evaluate the signal has positive costs. Some aspects of the signal, such as the number of patents in a firm's portfolio, present lower evaluation costs than others, such as interpreting the information contained in each patent. If observers' information costs are high enough, a firm might not realize any positive return on its investment in signaling through patents.

Investors can respond to verification costs in various ways. One response is for observers of the signal to verify the signal themselves. Alternatively, investors can use third-party experts. If the aspect of a patent signal to be verified is whether the firm actually has the patent, this presents low verification costs. But if the aspect of the signal to be verified is anything other than who owns it, the verification costs rise considerably. If each investor had to shoulder all the verification costs of the information contained in a patent, this would duplicate effort and waste resources. Collective mechanisms can reduce investors' verification costs.

Why use collective mechanisms to reduce verification costs? Why not just rely on firms' reputations? After all, if patents are a means of conveying information, and if investors are concerned with the accuracy of the information, why not just rely on firms' reputations for honesty? Reliance on reputation, without more, proves problematic for several reasons. Firms may not have established reputations, perhaps because they have not had the time or capital to do so. Start-ups and first-time patentees would have a difficult time convincing observers of the veracity of the statements contained in the patent. Patentees would not be able to reap the benefits of a reputation for honesty without establishing a reputation for honesty. But they could not establish a reputation for honesty unless others were to measure the honesty of their statements. Firms with short-term horizons (such as those that intend to get only one patent before being bought out) may have insufficient incentives to invest in a reputation for honesty, or to signal honestly with the patent.

2. The credibility of the information conveyed.

Several mechanisms exist to increase the credibility and clarity of the information conveyed by patents and portfolios and thereby reduce the costs of verifying and evaluating the signal. First, consider the role of the PTO as an agent for reducing the evaluation costs of information.\footnote{Examples of information intermediaries in other contexts include accounting firms, law firms, rating agencies, investment banking firms, and venture capital funds. For a discussion of the role of venture capital funds as informational intermediaries, see Bankman and Gilson, 51 Stan L Rev at 300–01 (cited in note 103) (arguing that venture capitalists may have greater expertise in marketing and developing new products); Alon Brav and Paul Gompers, Myth or Reality?: The Long-Run Underperformance of Initial Public Offerings: Evidence from Venture and Nonventure Capital-Backed Companies, 52 J Fin 1791, 1792–93 (1997) (examining the relationship between venture capital backing and IPO performance); Paul Gompers and Josh Lerner, Conflict of Interest in the Issuance of Public Securities: Evidence from Venture Capital, 42 J L & Econ 1, 24–26 (1999) (concluding that evidence from venture affiliates of investment bankers suggests that the market discounts for potential conflicts of interest). But see Frank Partnoy, The Siskel and Ebert of Financial Markets?: Two Thumbs Down for the Credit Rating Agencies, 77 Wash U L Q 619, 711 (1999), for a skeptical view of rating agencies as intermediaries.} The PTO can serve as an intermediary because it is a repeat player that may suffer a reputational loss when it allows a patent to issue that contains obvious errors.\footnote{See, for example, David L. Strom, Hyper-Light-Speed Antenna, U.S. Patent No 6,025,810 (Feb 15, 2000) (“The present invention takes a transmission of energy, and instead of sending it through normal time and space, it pokes a small hole into another dimension, thus, sending the energy through a place which allows transmission of energy to exceed the speed of light.”).} The PTO offers its own evaluation of certain aspects of the information contained in the patent. At least in theory, issuance of a patent stands for the proposition that the PTO has reviewed the information contained in a patent and declared that it describes something new, useful, and nonobvious.\footnote{The requirements of utility, novelty, and nonobviousness can be found in 35 USC §§ 101 (1994), 102 (1994 & Supp 2000), and 103 (1994 & Supp 2000), respectively.} Put more precisely, issuance of a patent represents that the PTO was unable to disprove the patentee’s claim that the information describes an invention that is new, useful, and nonobvious.\footnote{Once a patent applicant submits an application to the PTO, the burden of persuasion and the initial burden of production are shifted to the PTO. In re Oetiker, 977 F2d 1443, 1449 (Fed Cir 1992) (Plager concurring).} By centralizing the function of taking a first shot at evaluating the information contained in a patent and publishing the patent once it is issued, the PTO presents economies of scale and experience in evaluating the attributes of a patent.\footnote{Economies of scale generally arise when average costs decline as output increases. See Dennis W. Carlton and Jeffrey M. Perloff, Modern Industrial Organization 35 (3d ed 2000). Economies of experience arise because all else equal, entities get better at things as they do them more.} Because the PTO, unlike the patentee, is a super-long-term player in the patent process, there are no final-period problems.

The PTO is an imperfect mechanism, however, for assuring that the information contained in a patent is credible. The PTO’s evalua-
tion of a patent may be so poor or hurried as to be near meaningless. Most of the assertions made by a patent applicant are taken on faith; only rarely does the PTO seek verification of a patent applicant's assertions. Complaints about the PTO's ability to screen patent applications adequately have been increasing. Under tight budgets and notoriously tight time schedules, the PTO lets patents slip through that contain incredible information.

In addition to PTO review, another way to increase the credibility of the information contained in a patent is to impose penalties on patentees who provide false information. The inequitable conduct provisions of patent practice are one mechanism that links penalties with inaccurate patentee statements. Recall that patentees can lose an issued patent, and potentially suffer worse penalties, for making inaccurate statements in the document. By imposing higher costs on patentees who would attempt to take advantage of high observer verification costs by making false statements in the patent, penalties for inequitable conduct make it more costly for dishonest firms to mimic the behavior of honest firms. By limiting the actions patent applicants can take in the course of obtaining a patent or attaching consequences such as loss of the patent (and more) to some actions, such as misrepresentation before the PTO, legal rules affect not only what actions patentees take, but what inferences observers can draw from those actions.

The penalties of inequitable conduct do not insure that the information contained in a patent is completely credible. To be sure, applicants are under a general “duty of candor and good faith” in all their representations before the PTO. Patentees warrant that the information contained in an issued patent is not known to them to be false, and if it is inadvertently false, it is not materially so. But the in-

118 See, for example, Revised Utility Examination Guidelines, 64 Fed Reg 71440, 71441-42 (1999) (discussing assertions of utility).
119 See, for example, Lemley, 95 Nw U L Rev at 1495–96 (cited in note 2) (citing sources).
121 See text accompanying notes 64–70 for a discussion of the inequitable conduct provisions.
122 See id.
123 By requesting a reexamination of its own patent, a patentee can signal its confidence about the soundness of the patent to observers. A patentee is unlikely to challenge its own patent unless it believes the patent will be upheld on reexamination.
124 37 CFR § 1.56, commonly referred to as “Rule 56,” calls for applicants to disclose only information material to the patentability of a claim of which they are aware.
125 It is not surprising that patentees warrant aspects of the patent that are under their own control (for example, does the invention do what the patentee claims it does?) and are least likely to be affected by the actions of others (will market conditions allow the product to sell
equitable conduct provisions apply only to certain types of information. Applicants are under an obligation to disclose "all information known to that individual to be material to patentability." This creates the incentive for patentees to remain willfully ignorant of information that might weaken the patent application, thus lowering the information value of the patent.

The threat of punishment for inequitable conduct is further weakened by the cost of detecting the misstatements. Patentees know that before they can be prosecuted for inequitable conduct, a third party must incur the costs of detecting the misstatements. Knowing this, firms may have the incentive to make statements that are misleading but are unlikely to be detected. The accuracy of the information contained in the patent may not be readily determinable, and observers might have to spend substantial resources to determine whether the patentee's implicit warranty of accuracy has been violated. Subsequent events will not necessarily reveal the accuracy of the statements made in the patent. Even if the information contained in a patent is facially inaccurate, competitors may not find it worth their while to bring a challenge.

Despite the weaknesses of the inequitable conduct provisions, few patentees have ever been found to make misstatements severe enough to warrant punishment. It's not for lack of trying on the part of third parties. Nor is it because the charge isn't taken seriously.

126 37 CFR § 1.56(a).

127 Commentators appear to disagree on the extent to which this incentive induces willful ignorance in practice. According to Glenn S. Tenney, past chair of the Intellectual Property Committee of the Institute for Electrical and Electronic Engineers, patent attorneys advise their clients only to reveal information they already know, and not to search for additional information, lest it reveal material that adversely affects the patentability of the invention. Panel Explores Validity of PTO Practices in Examining Business Method Patents, 60 BNA Patent, Trademark & Copyright J 278, 280 (2000). Ron Laurie, an attorney with Skadden, Arps, Slate, Meagher & Flom in Palo Alto, disputes Tenney's argument. Id at 280–81. Laurie contends that companies looking to go public actively want to avoid having bad patents in their portfolios. Id. According to Laurie, IPO underwriters closely scrutinize the strength of patent applications. Id. If additional searching would reveal weaknesses in the patent application, the underwriters' counsel wants to know. Upon closer inspection, these two streams of thought are compatible. Patentees may desire to remain ignorant of information that adversely affects the patentability of the invention, so as to avoid the worst (or perhaps all) of the inequitable conduct penalties, whereas underwriters, who act as reputational intermediaries, may want to find out information that affects the patentability of the invention.

128 There has been no shortage of patentees charged with making misstatements. See Molins PLC v Textron, Inc, 48 F3d 1172, 1182 (Fed Cir 1995) ("[U]njustified accusations ... are offensive and unprofessional ... [and] should be condemned."); Kimberly-Clark Corp v Johnson & Johnson, 745 F2d 1437, 1454 (Fed Cir 1984) ("'Fraud in the PTO' has been overplayed, is appearing in nearly every patent suit, and is cluttering up the patent system."). See also Robert J. Goldman, Evolution of the Inequitable Conduct Defense in Patent Litigation, 7 Harv J L & Tech 37, 85–87 (1993) (discussing the deference afforded to trial courts in making determinations of fraud).
Perhaps patentees are not making very many misstatements in their patents. Or perhaps patentees are lying so cleverly that challengers cannot meet their burden of proof. Or maybe some patentees are lying, but not in the patents being challenged. Whatever the explanation—and nobody really knows what it is—few patents are lost because of lying by patentees.

Second tier informational intermediaries ("STIIs") are another institutional mechanism for verifying the quality of the information contained in the patent. If the PTO offered an accurate appraisal of whether the patent application enabled a person of ordinary skill in the art actually to make and use an invention that was new, useful, and nonobvious, and if such an appraisal resulted from a detailed study, observers may not find replicating the PTO's work worthwhile. If, on the other hand, the PTO's appraisal of a patent application is perceived to be inaccurate a sufficiently high percentage of the time, then observers may find it worthwhile to repeat the work of the PTO, in addition to conducting further evaluation. Similarly, if observers question the PTO's reputation for independence, its value as an intermediary could diminish. Only if the PTO and patentees do not have aligned interests can the PTO's evaluation of patent applicants be believable, which is why the PTO's recent focus on becoming more "inventor-friendly" and treating patent applicants as "clients" rather than quasi-adversaries may damage its credibility. Because the PTO is not subject to legal liability if it blunders or allows a fraudulent patent to slip through, the credibility of the PTO as an intermediary is limited. As a result, observers may choose to rely on STIIs that evaluate the PTO's work.

In recent years, STIIs have emerged that double check the quality of the work of the first tier informational intermediary, the PTO. One such STII is called BountyQuest. Patent challengers not content to accept the PTO's evaluation can pay BountyQuest to attempt to gather information that could defeat the patent. Patent challengers

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129 The Court of Appeals for the Federal Circuit has indicated that it intends to enforce the patent applicant's duty of candor. See, for example, Semiconductor Energy Laboratory Co, Ltd v Samsung Electronics Co, Ltd, 204 F3d 1368, 1377–78 (Fed Cir 2000) (holding that providing misleading translations of relevant documents is a violation of the duty of candor); Elk Corp v GAF Building Materials Corp, 168 F3d 28, 30 (Fed Cir 1999) (stating that patent applicants and their attorneys must prosecute their applications in the PTO with candor, good faith, and honesty); Baxter International, Inc v McGaw, Inc, 149 F3d 1321, 1329–30 (Fed Cir 1998) (noting that withholding information about the state of the prior art from the PTO violates the duty of candor); Refac International, Ltd v Lotus Development Corp, 81 F3d 1576, 1581 (Fed Cir 1996), citing Molins, 48 F3d at 1178, for the idea that failure to disclose material information constitutes inequitable conduct.

130 For example, rating agencies such as Moody's and Standard & Poor's serve as a reputational intermediary for bonds and other fixed-income investments.

pay a fee (the “posting fee”) to BountyQuest, which then posts on its website for one month a cash award for information that would invalidate issued patents. The website indicates the information BountyQuest needs, the amount of the award, and when the offer expires. Individuals hoping to claim the bounty (“bounty hunters”) submit documents such as scientific and engineering articles purporting to show that the patent is not valid. It remains to be seen whether STIIs such as BountyQuest will become regular players in the market for evaluating patents. STIIs face a classic chicken and egg problem in getting started. It is difficult for an STII to attract clients willing to rely on its judgment until it develops a reputation for evaluating patents in ways that hold up under judicial scrutiny, but it cannot develop a reputation without analyzing patents. If investors and other market actors care enough about evaluating and measuring the attributes of patents, STIIs and other mechanisms to reduce evaluation costs may become more popular.

B. Signal Quantity and Quality

Is the patent system more efficient or credible than other means of conveying information to observers? Securities regulations govern one mechanism by which information about a firm can be conveyed. A detailed comparison of the patent system with securities law as a means of conveying information credibly and cheaply is beyond the scope of this Article, but a few general comments are in order.

If patent signals duplicate the quantity and quality of information that would be conveyed to observers through other means such as securities disclosures, then the patent system’s value as a signaling mechanism may be low. Similarly, unless patents and portfolios are able to convey information more cheaply and reliably than other mechanisms, the patent system’s usefulness and efficiency as a signaling mechanism must be questioned. But if the patent system is able to convey more information than other mechanisms such as securities disclosures, or convey the information more cheaply or credibly, or convey information different from that conveyed by alternative mechanisms, then we would expect its signaling function to be valuable.

One context in which patents and portfolios would serve a particularly useful signaling function is conveying information in contexts not subject to securities regulation. We would therefore expect publicly held firms and privately held firms to use patents and portfolios differently to convey information. We would expect public firms to focus on maximizing the size of their patent portfolios, whereas private equity firms—which are not subject to securities regulations—would
seek to maximize both the quantity and quality of the information disclosed. Here's why.

As I have argued, patent signals have costs that will vary along different margins. Just as information costs will vary, we can expect that firms' and observers' willingness to bear the costs of interpreting the patent signal will vary. Because patents are useful in reducing informational asymmetries between firms and capital markets, we would expect firms to care more about patent signaling when informational asymmetries are large and when alternative means of conveying information credibly are limited.

Informational asymmetries are particularly acute when the company is a start-up firm. Start-ups have short histories, no market reputation, and frequently are in niche markets, often in fast-moving industries. This combination of factors makes measurement of their growth prospects, and hence valuation, difficult. All else equal, we would expect the marginal benefit of a credible means of conveying information to be higher for a firm that has no market reputation than for a firm that can rely on an established reputation. Patent applications, which are kept secret until the patent is granted, can provide credible information to investors while keeping it out of the hands of competitors.132

As firm R&D increases, so too does the information asymmetry between managers and investors.133 The harder the projects are to value, the more likely they are to be undervalued. Firms that undertake hard-to-value projects experience greater share undervaluation than do firms that engage in projects that are easy to value.134 Start-up firms and firms engaging in research projects that are difficult to value would particularly benefit from mechanisms that allow them to convey credible information about their positive attributes to their relevant audiences. If it is indeed the case that firms engaging in more R&D get more patents or convey more information through patents,

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132 See 35 USC § 122 (1994). A pending patent application is published after eighteen months unless the patent applicant requests continued confidentiality and certifies that it has not filed for patent protection on the same invention in another country. Id. We can expect start-up firms to be less likely to file patent applications abroad and therefore more likely to request confidentiality throughout the pendency of the application. The term of protection begins on the issue date and ends twenty years from the date the inventor filed the application. 35 USC § 154(a)(2) (1994).
133 David Aboody and Baruch Lev, Information Asymmetry, R&D, and Insider Gains, 55 J Fin 2747, 2749 (2000) (arguing that R&D is a major contributor to information asymmetry and insider gains, raising issues concerning management compensation, incentives, and disclosure policies).
then patents may serve to create a separating equilibrium among firms.

Just as firms have incentives to focus more on signals the more important it becomes for them to convey information to the market, we might expect investors in start-ups to be more willing to incur costs analyzing patent signals than would investors in more established firms. Unlike shareholders in public firms, who are able to challenge the power of corporate management to set the firm’s strategic agenda through a variety of control and enforcement mechanisms—both exit and voice—private equity investors have voice but not exit. As a result, investors will be stuck with the losses if the firm should fail. Lack of financial history and reputation make valuation of the firm particularly difficult and increase the chance of insiders exaggerating the start-up’s prospects and opportunistic behavior after financing is received. When a firm has investments in hard-to-value projects and there is asymmetric information regarding the value of those projects, managers may engage in rational myopia—sacrificing long-term value by boosting current earnings in order to increase short-term share values and prevent (or attract) a corporate takeover.

Investors in privately held firms must determine the attributes of the firm in which they are investing, but measurement of such attributes is costly. Because entry and exit is more difficult for investors in a privately held firm, such investors can be expected to place a higher marginal value on gaining information about each firm’s attributes than would investors in publicly held firms. This higher tolerance for measurement costs on the part of investors creates an incentive for privately held firms, more than publicly held firms, to signal to capital markets in greater detail.

Indeed, evidence indicates that observers place greater emphasis on patent counts (as opposed to measuring the attributes of individual patents) of established firms, but focus on both the quantity and quality of patents and patent applications in the portfolios of less-established firms. It is not surprising that observers become more

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135 Entry and exit by investors from privately held firms is more difficult due to the extended time horizon of the relationship created by the illiquidity of the securities and the customary existence of lock-up clauses in the investing agreement. For a general discussion, see Albert O. Hirschman, Exit, Voice, and Loyalty: Responses to Decline in Firms, Organizations, and States 21–29 (Harvard 1970).


137 Compare studies of established firms, such as Cohen, Nelson, and Walsh, Protecting Their Intellectual Assets: Appropriability Conditions and Why U.S. Manufacturing Firms Patent (Or Not) at 16 (cited in note 28); Griliches, 28 J Econ Lit at 1673, 1684 (cited in note 74); and Pakes, 93 J Politi Econ at 392 (cited in note 76) (focusing on patent counts), with descriptions of what venture capitalists and IPO underwriters value, such as Kortum and Lerner, 31 RAND J
willing to incur measurement costs the less established the firm is. Venture capitalists place heavy emphasis on the personal characteristics of the entrepreneurs in whose firms they invest. The future value of a start-up is uncertain and is heavily dependent on the judgments of the entrepreneurs running it, so the quality of the entrepreneurs is important. The benefit from measuring the marginal value of an entrepreneur’s skill may be significant. Evidence of the skills and talents of entrepreneurs in a start-up firm will influence investors more than evidence of managerial skill in an established firm. How could patents inform investors of the marginal quality of entrepreneurs? Patents may operate as a separating mechanism that identifies those entrepreneurs with sufficient confidence in their inventions to spend money communicating them in the form of a patent.

Capital investments, usually from venture capitalists and other private equity sources, represent the most important funding source for many firms, particularly early-stage firms. Evidence indicates that financing constraints are more pressing for smaller firms. In particular, capital constraints appear to limit R&D expenditures. As a result, we can expect smaller firms to experience higher opportunity costs for not signaling. Evidence that smaller firms may signal more than large ones can be found in the fact that smaller firms patent more intensely per dollar of R&D.

This phenomenon may have undesirable consequences. Because the firm’s allocation of its efforts will be difficult to observe, it has the incentive to devote resources to influencing the investors’ decision, resources which may be devoted away from productive activity. Knowing that a portfolio of patents and patent applications is one feature investors look for when analyzing the firm, start-ups may choose to obtain the largest portfolio of patents possible, even if obtaining pat-

Econ 674 (cited in note 87) (examining patenting and venture funding); 60 BNA Patent, Trademark & Copyright J at 280–81 (cited in note 127) (stating that IPO underwriters scrutinize patent quality). See also Lemley, 95 Nw U L Rev at 1504 (cited in note 2) (stating that large companies rely on portfolio “volume rather than quality” in licensing negotiations).


139 See Hubbard, 36 J Econ Lit at 215 (cited in note 138) (arguing that available evidence suggests that within-firm variation in R&D spending is explained substantially by the within-firm variation in internal finance).


141 See text accompanying notes 51–52.
ents reallocates resources away from more profitable activities like R&D. This reallocation of resources results in a riskier venture for investors because of the firm’s decreased productivity and the decreased accuracy of the information the firm provides to the investor, resulting in a decrease in the quality of the investor’s decision.

C. Welfare Effects

One frequently encounters the sentiment that the “[t]he state of the art in the economics of . . . patent policies seems primitive.”142 And so it is. Because the functions and effects of the patent system are central to much innovation policy, a better understanding of the reasons patentees might seek patents and the costs and benefits of patents has important implications.143 To the extent patenting creates a separating equilibrium, patents can allow firms to reduce information asymmetries in capital markets. As a result, the welfare costs and incentive effects of legal rules may be different from those anticipated by commentators and lawmakers who only consider the exclusionary aspects of patent protection. We need to explore further the ultimate efficiency of patents as informational mechanisms. If patents are efficient at reducing information asymmetries, what normative implications does this have for other aspects of patent rights, such as the length of the patent term and the scope of the rights that should be granted? On the other hand, if patents are inefficient mechanisms for signaling or even for directly conveying information, what (if any) legal rules ought to be changed and how? To what extent are patent signals and exclusionary rights interrelated? A complete welfare analysis of the patent system is too complicated to undertake here, but in what follows I highlight a few aspects of patent signals that warrant further, and future, consideration.

Does patent signaling use resources, and if so, does it use them efficiently? Certainly obtaining a patent has costs, both private and social. Whether patent signaling is efficient largely depends upon whether one believes patent signaling discloses new information that would not have been available otherwise or whether it reveals information that would have been revealed in time anyway. In other words, do patents convey new information about firms or are they just examples of foreknowledge gains?144

142 Kaplow, 97 Harv L Rev at 1889 (cited in note 11).
143 See, for example, Lanjouw, Pakes, and Putnam, 46 J Indus Org at 429–30 (cited in note 90) (discussing useful insights derived from patent renewal and applications data, and directions in which this type of analysis could be further developed).
It may be that the patent system simply identifies firms that produce better research. They would produce equally good research regardless of whether patents signaled their type. In that case, the signaling function of the patent system has no productive value. It produces a redistribution of resources in capital markets but no increase in total product. The private value of having information about the firm revealed more quickly may be positive, but the social value may not. For example, it may be privately valuable to learn in advance which horse will win a race but that does not mean that such foreknowledge gains increase social welfare. Similarly, if patent signaling merely increases foreknowledge, the social benefits of patent signaling may be trivial and the costs may result in a social loss. Under those circumstances, the overall signaling value of patents may be negative.

On the other hand, to the extent patent signals increase allocative efficiency, there may be real social gains. Suppose that a firm has different advantages in the various areas in which it is conducting research. If this is the case, then patenting may serve as a sorting mechanism that will increase total welfare. The sorting mechanism may operate both ways: not only do investors learn about firm type from patents issued, but firms learn about their own type (or more realistically, their own strengths and weaknesses within their research projects).

Patent signaling may create distorted incentives for firms. Along quantity margins, firms may have the incentive to engage in behaviors beyond the level at which they would if the behaviors sent no signal. For example, if the size of a patent holder’s portfolio is used as a signal, then this creates the incentive for patent holders to patent the smallest publishable unit, and divide what would normally be a single patent on an invention into multiple smaller patents on different facets of the same invention. In the end, the same amount of inventing takes place, but the patent holder’s portfolio is larger than it would be if portfolio size were not a proxy. The end result is a net social loss: the PTO must examine more patents than it otherwise would, with a concomitant waste of administrative resources; would-be licensees of the invention must now take out a bundle of licenses, not just one, from the patent holder on an invention that has been sliced into thin strips of rights; and both parties to the transaction incur more transaction costs in the form of administrative costs and lawyers’ fees.

Along quality margins, firms may focus on manipulating the contents of the signal by “ puffing,” rather than focusing on assuring the quality of the underlying patented product. To the extent that such ac-

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145 For a general discussion, see R. Glenn Hubbard, ed, Asymmetric Information, Corporate Finance, and Investment (Chicago 1990) (arguing that conditions of asymmetric information can lead to inefficient signaling); Ayres, 77 Va L Rev at 946–47 (cited in note 100).
tivity chisels away at the boundaries of the inequitable conduct provisions, it creates an adverse selection problem and reduces the value of patents as signaling mechanisms. Firms may also choose to behave strategically, obfuscating information in patents and attempting to compile portfolios that deliberately obscure information about the firm so as to foil the would-be Lemelsons of the world.

Excessive signaling could occur if there is a divergence between the private and social benefits of signaling. One of the private benefits of signaling is the reduction in the firm's cost of capital through reducing investors' information costs. If the firm is publicly held, another benefit is the increase in stock price to the extent signaling allows this to occur more quickly than it would in the absence of signaling. The social benefit of patent signaling is the increase in market efficiency because of the existence of more information about the firm. Even if excessive signaling is inefficient, it still may be more efficient than the information costs observers might incur in the absence of patent signals. Without patents to provide a window (however hazy) into the firm, investors might carry out inefficient searches in pursuit of better information. When the two types of inefficiencies are netted out, the firm's informational advantage may render excessive signaling by the firm preferable to excessive searches by investors. It is unlikely that attempts to prevent excessive signaling would be feasible. If avenues of signaling through patents were shut down, others would open up.

On the other hand, the social benefit of better information might be swamped by the costs of producing it. Even if the patent system is one of the best means of conveying information to observers, that alone does not make it efficient. If the absolute cost of patent signaling is sufficiently high, it may be more efficient to force innovative and boring firms to pool, rather than bear the administrative costs of allowing patent signaling in order to get separation between types. Ultimately, distinguishing between firms using signals to determine the attributes of a firm may have important effects on allocative efficiency. Considering the allocative effects of intellectual property portfolios on information in capital markets leads to a richer and more realistic portrayal of the reasons for which patents may be obtained, but it leaves unresolved the question of whether such outcomes enhance efficiency.

146 John C. Coffee, Jr., Market Failure and the Economic Case for a Mandatory Disclosure System, 70 Va L Rev 717, 733–34 (1984), suggests that the inefficiencies generated by investors' excessive searches justify the imposition of mandatory disclosure requirements on firms.

147 Philippe Aghion and Benjamin Hermalin, Legal Restrictions on Private Contracts Can Enhance Efficiency, 6 J L, Econ, & Org 381, 383–87 (1990) (showing that efforts to separate goods and bad types may lead good types to signal too much and proposing restrictions on signaling in order to enhance efficiency).
The costs of interpreting patent signals are positive and vary under different circumstances. When evaluation costs are high, market actors have the incentive to measure along easily evaluated margins. Knowing that measurement of the value of their attributes will be incomplete, firms will have several strategies for using intellectual property to signal their value to capital markets. One of these is to maximize the portfolio along the margin of readily measurable attributes. Since the number of patents a firm has received is a measurable attribute of a portfolio whereas the quality of individual patents is not, firms have the incentive to cover the same amount of subject matter in a portfolio with more rather than fewer patents.

Investors will know that the sheer size of an intellectual property portfolio is an imperfect indicator of firm quality. If the signal sent by patents counts is ambiguous (as when a pooling equilibrium occurs), it may be useless as an indicator of firm quality. Investors may choose instead to rely on other signals. Alternatively, they may choose to examine individual patents more closely. This will be much more costly than relying on sheer patent counts.

Individuals have limited capacities for acquiring and using information, over which one can expect diminishing returns. The more information an individual is given to process, the lower the marginal capacity to process each piece. Evaluation costs of information also require that individuals be able to distinguish one signal from another. As with learning a foreign language, an activity in which individuals must make irreversible investments, recognizing and deciphering patent signals requires an initial investment. Similarly, evaluating the information contained in a patent requires special skills that can ordinarily be obtained only through investment in expensive training. Having learned to interpret a signal, individuals may be loath to invest in acquiring another means of evaluating the signal. Once the investment has been made and the means of evaluating the information acquired, it will be cheaper to keep relying on it than to invest in new channels. This is especially true because the scarcity of the individual interpreter as an input implies that acquiring new evaluation techniques will diminish the product of old ones. Even if subsequent information suggested that the signal was noisy, it would not pay to invest in another means of signaling (or interpreting the signal) unless the expected benefits of learning the new means of signaling were greater than the expected benefits under the old system plus the costs of learning the new system (because investors will treat the cost of acquiring the expertise to interpret the signal through the old means as a sunk cost). As a result, the use of patents as a signaling mechanism may be sticky even if it is somewhat inefficient.
CONCLUSION

A theory that attempts to place a value on intellectual property should consider the role patents can play in mitigating informational problems in capital markets. Intellectual property rights may be valuable not just because such rights can create scarcity to public goods in product markets, but also because they can be used to convey credible information at low cost to observers and reduce informational asymmetries between firms and investors. To the extent that patents reduce information costs about the attributes of the firm obtaining the patent, firms can derive positive returns from obtaining patents, returns above and beyond the rents captured in product markets.

The opportunity to gain these positive returns could provide an incentive to seek patents beyond the point that firms otherwise would if appropriability conferred the only value of the patent. This might shed light on why firms continue to seek patents avidly even when they expect little in capturable rents. To be sure, the value of intellectual property as a means of conveying information in capital markets is much more conjectural than the value of its use in product markets. As a result, it is more likely to be underestimated. This might explain why the value of patents as a means of reducing information asymmetries in capital markets has previously been overlooked.

Theoretical analyses and empirical studies of the private value of patents proceed on the basis of a simplified notion of the incentives behind patenting. Relaxing the simple view's assumption that the final value of a patent stems solely from the exclusivity conferred by legal rules and giving the role of information a more central place in the analysis of patent rights will create a more nuanced understanding of the intellectual property system.