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Gregory N. Mandel

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PROXY SIGNALS: CAPTURING PRIVATE INFORMATION FOR PUBLIC BENEFIT

GREGORY N. MANDEL*

ABSTRACT

This Article presents an original empirical methodology to identify which patent laws will best promote optimal incentives to innovate for society. Vociferous debates over patent reform pit the United States' largest innovation industries against each other in a dispute concerning whether stronger or weaker patent rights are necessary to promote innovation. Past efforts to answer this question have been thwarted by an inability to parse the impossibly complex social and legal relationship between innovation and patent law. Rather than considering such problems directly, the proxy technique introduced here offers a new framework to leverage indirect signals that capture better information than previously available concerning how best to promote incentives to innovate. In certain contexts, it is possible to use empirical information about the trade-off between the incentives and exclusivity costs of patent law to identify particular private industries that (1) face trade-offs

 Peter J. Liacouras Professor of Law and Associate Dean for Research, Temple University—Beasley School of Law. J.D., Stanford Law School; B.A., Wesleyan University. I am grateful for valuable comments on earlier drafts of this work from Jonathan Barnett, Jane Baron, Michael Carrier, Christopher Cotropia, Ben Depoorter, Ezra Friedman, Brett Frischmann, John Golden, Craig Green, David Hoffman, Robert Hunt, Mark Lemley, Clarissa Long, Michael Meurer, David Post, Ted Sichelman, and Chris Sprigman, and for feedback from participants at the University of Pennsylvania Law School's Center for Technology, Innovation, and Competition Workshop, the 2010 Intellectual Property Scholars Conference, the Cyberlaw Colloquium at Rutgers School of Law, the Boston Intellectual Property Colloquium at Suffolk Law School, and The Future of Patent Law conference at the University of San Diego School of Law. I also want to thank Carolyn Castagna, Douglas Maloney, and Evan Smith for their outstanding research assistance on this project.

equivalent to those that society faces, and (2) possess far superior information concerning how best to balance such trade-offs. Where industries satisfy both criteria, their private preferences will happen to align with social innovation objectives and can be mined for previously untapped, socially beneficial information. The proxy signal approach provides a new public choice methodology, designed to leverage the strength of collective private industry and market knowledge, in a manner that can be applied to other legal domains beyond patent law.

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INTRODUCTION

Vociferous patent reform debates have sprawled across the judiciary, Congress, and the Executive Branch for the past dozen years. The most recent iterations of the disputes center on the newly enacted America Invents Act[1] and recent Supreme Court decisions in *Mayo v. Prometheus*,[2] *Microsoft v. i4i*,[3] and *Bilski v. Kappos*.[4] Ironically, adversaries on all sides of these patent debates agree on their normative objective: to design a patent system that will optimize the incentives to innovate for society.[5] The parties disagree, however, on what form of patent law will achieve this treasured goal. Will ratcheting up patent protection generate greater incentives to drive technological advance, or create barriers to access that stifle future innovation? Will weakening patent protection make complex innovation no longer worth the effort, or produce a more open, synergistic, and generative innovation environment?

Trying to parse the relationship between patent law and innovation presents an extremely challenging question. Innovation is a complex social phenomenon involving significant uncertainty, varied creative and motivational influences, and convoluted spillover and feedback dynamics, all of which are difficult to measure or predict. Layered on top of the social phenomena of innovation is the complex legal system of patent law, muddying the analysis even further. It is not surprising that the myriad efforts undertaken to understand the effects of the patent system have produced a mass of information, but limited awareness concerning whether any given legal change actually promotes or retards innovation.[6]

This Article introduces a novel empirical methodology designed to identify which patent laws will best promote incentives to innovate for society, and where patent law currently stands in relation to providing optimal incentives to innovate. This method is based on confronting complex social welfare issues from a new direction. Instead of trying to evaluate the relationship between patent law and innovation directly, this

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1. H.R. 1249, 112th Cong. (2011).
2. Mayo Collaborative Servs. v. Prometheus Labs., Inc., 132 S. Ct. 1289 (2012).
3. Microsoft v. i4i Ltd. P'ship, 131 S. Ct. 2238 (2011).
4. 130 S. Ct. 3218 (2010).
5. *See infra* Part I.B.
6. ROBERT P. MERGES, JUSTIFYING INTELLECTUAL PROPERTY 2 (2011); Dan L. Burk & Mark A. Lemley, *Policy Levers in Patent Law*, 89 VA. L. REV. 1575, 1581 (2003); FRITZ MACHLUP, STUDY OF THE U.S. SENATE SUBCOMMITTEE ON PATENTS, TRADEMARKS & COPYRIGHTS: AN ECONOMIC REVIEW OF THE PATENT SYSTEM 79–80 (1958).

methodology develops an original public choice approach that captures private market and industry innovation information to indicate how patent incentives can be optimized.

The most fundamental question in patent law, on which both proponents and opponents of patent reform agree, concerns how to identify the level of patent protection that will optimize the incentives to innovate for society.[7] Too little protection reduces incentives to invest resources and to innovate in the first instance. But, too much propertization creates its own barriers to innovation, stifling the further development and dissemination of innovation products. Patent law seeks the level of protection that balances the trade-off between the benefit of incentives and the cost of limiting access so as to produce the greatest net incentives to innovate for society.[8]

Conventional patent analysis involves attempting to measure and balance the well-recognized trade-off between incentives and exclusivity directly.[9] Decades of effort appear to establish that we cannot accomplish this task. Rather than attempting to identify laws that produce optimal trade-offs directly, the framework introduced here develops a method that instead relies on *indirect signals* to indicate where current law stands in relation to the optimum. This method uses empirical information about the characteristics of innovation in different industries to identify particular private entities that both (1) face trade-offs equivalent to those that society faces as a whole, and (2) possess far superior information concerning how best to balance such trade-offs. Where private entities satisfy both criteria, their private preferences will happen to align with social objectives. In these select situations, private preferences can be leveraged as *proxies* to obtain previously unrecognized, socially beneficial information about how to best design the law.

This proxy signal approach involves four general steps: first, identifying structural industry characteristics that affect a private

7. *See infra* Part I.

8. *See Mayo Collaborative Servs.*, 132 S. Ct. at 1293–94 (describing the goal of patent protection as desiring to balance the incentives of the promise of exclusive rights against cost of exclusivity); Sony Corp. of Am. v. Universal City Studios, Inc., 464 U.S. 417, 429 (1984) (describing intellectual property as requiring "a difficult balance between the interests of authors and inventors in the control and exploitation of their writings and discoveries on the one hand, and society's competing interest in the free flow of ideas, information, and commerce on the other hand."); Richard A. Epstein, *The Disintegration of Intellectual Property? A Classical Liberal Response to A Premature Obituary*, 62 STAN. L. REV. 455, 458–59 (2010) ("Figuring out how to trade off exclusive ownership that gives strong incentives for commercialization against the free but uncoordinated use of information . . . offers the single greatest challenge to preserving the health of the law of copyrights and patents.").

9. *See infra* Part I.B.

industry's preferences with respect to patent law; second, evaluating which industry characteristics will tend to cause an industry to face the same incentive and exclusivity trade-offs as society; third, selecting industries with trade-offs that mirror the socially desired balance (i.e., industries that are proxies for social incentive objectives); and fourth, evaluating the selected industries' legal preferences, such as by studying their legislative and judicial advocacy efforts, to obtain indirect proxy signals concerning socially beneficial law. These steps are described in more detail below.

Step One. It is now well recognized that different industries interact with the patent system in widely different manners. This variation arises due to differences in industry innovation characteristics. Some industries (e.g., pharmaceuticals) require costly research and development to innovate; others (e.g., software) do not.[10] Some industries (e.g., semiconductors) have many alternatives to patent protection to profit from their innovation; others (e.g., medical devices) do not.[11] Because industries vary in their innovation characteristics, they also vary in how they are affected by the incentives and exclusivity costs of patent law.[12] This variation, in fact, is exactly why the country's most powerful technology industries have been locked in a decade-long battle over patent reform.[13]

Step Two. Innovation routinely produces both positive external spillovers and negative external limitations on access. Due to these innovation externalities, most industries do not face socially optimal incentives to innovate, but instead are incentivized to desire stronger or weaker patent protection than is socially optimal.[14] The industry innovation characteristics identified in Step One can be evaluated to determine which industries have characteristics that tend to produce relatively fewer innovation externalities. These industries will face incentive versus exclusivity trade-offs that are more similar to society as a whole. Whether an industry is a net producer or net consumer of innovation provides an illustration. Society as a whole desires patent law that balances the production and consumption interests in innovation: we

10. Burk & Lemley, *supra* note 6, at 1581–83.

11. Wesley Cohen et al., *Protecting Their Intellectual Assets: Appropriability Conditions and Why U.S. Manufacturing Firms Patent (Or Not)* (Nat'l Bureau of Econ. Research, Working Paper No. 7552 (2000)).

12. *See infra* Part III.D. Patent law currently provides, and is required to provide in certain respects under international law, relatively uniform doctrine across different areas of technology. This Article begins with a presumption of uniform patent law, a presumption that is relaxed later in the discussion. *See infra* Part III.F.3.

13. DAN L. BURK & MARK A. LEMLEY, THE PATENT CRISIS AND HOW THE COURTS CAN SOLVE IT 4, 100–02 (2009).

14. *See infra* Part II.A.

cannot consume innovation that we do not produce, and we do not want to pay more to use innovation than the minimum amount necessary for its production.[15] Private industries, however, do not necessarily balance producer and consumer interests. Some industries need relatively few patented inputs in order to produce and commercialize their own innovation. Such industries will face relatively low exclusivity costs from patent protection, but may receive particularly high benefits. Consequently, these industries would tend to favor stronger patent protection than is socially optimal. Other industries are in the opposite position.

Step Three. Some industries may happen to face, due to their particular innovation characteristics, socially balanced trade-offs between the production and consumption of innovation. That is, these industries need about the same value of innovation as inputs (consumption) as the value of innovation that they develop as output (production). Such industries will tend to prefer, for purely self-interested reasons, intellectual property law that balances the production and consumption interests in innovation. Consequently, these industries will desire, to a first order approximation, similar patent protection to that which society desires for this balance. Though this example only covers a single innovation characteristic (the production versus consumption of innovation), it provides a flavor for the analysis. In practice, multiple characteristics affect the incentives and exclusivity costs of patent protection, requiring the evaluation of private industry trade-offs versus societal trade-offs across a variety of technological, innovation, and market characteristics.

In essence, this process can be seen as a search for industries with few innovation externalities with respect to patent law. Industries with innovation characteristics that generate significant positive externalities (in the form of innovation spillovers), or negative externalities (in the form of limitations on access), with respect to innovation will tend to have patent law preferences that diverge significantly from societal preferences. Industries with few innovation externalities—those that take into account all of the positive benefits and spillovers from innovation, as well as all the limitations on access and costs of exclusivity produced by patent protection—will more closely parallel society's preferences. These "naturally internalized" industries can produce valuable proxy signals.[16]

15. Extraterritorial effects make this analysis more complicated, as a jurisdiction may actually be a net producer or net consumer of innovation due to the net export or net import of innovation. *See infra* Part III.F.6.

16. Maximizing net incentives to innovate is not precisely the same as maximizing social welfare

Step Four. Identifying industries that face similar trade-offs to society produces valuable signals because private industries possess vast, superior, and previously untapped information concerning the relationship between innovation and intellectual property law.[17] Not only does private industry have better information than public actors about innovation, as it engages in the innovation process directly, but private industry also better understands the relationship between innovation and patent law because it devotes substantial resources to examining this interaction. Competitive markets effectively require this outcome, as firms that are better able to manage this relationship will have a greater chance of succeeding in the market. The patent system is premised on this presumption. If public entities possessed equivalent information to industry concerning the relationship between investment and innovation, innovation could simply be publicly funded and made freely available.[18]

By investigating the preferences of industries that face similar intellectual property trade-offs to society, such as through studying these industries' legislative and judicial lobbying efforts, it is possible to indirectly obtain proxy signal information concerning the socially optimal level of patent protection. This information has never been captured before. Though this proxy approach requires significant data and analysis, it is still substantially more feasible than prior efforts to identify socially beneficial patent law. This is because proxy analysis is based upon evaluating technology and innovation characteristics, objective characteristics on which society possesses substantial empirical information, rather than requiring a relatively inchoate and seemingly irresolvable exploration of the direct relationship between law and innovation. Instead of relying on public actors to try to guess at the interaction between law and innovation, proxy analysis provides a way for public lawmakers to indirectly leverage the private warehouse of industry and market knowledge on innovation.[19] In this manner, proxy signals

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from innovation, but it is a common surrogate and these objectives are usually considered close. Analysis later in this article explains how differences between the two could be bridged. *See infra* notes 200–02 and accompanying text.

17. *See* Gillian K. Hadfield, *Producing Law for Innovation*, *in* RULES FOR GROWTH: PROMOTING INNOVATION AND GROWTH THROUGH LEGAL REFORM 23 (2011) (discussing the advantage of private markets for processing vast amounts of information and responding to complex issues).

18. *See, e.g.*, JAMES BOYLE, THE PUBLIC DOMAIN: ENCLOSING THE COMMONS OF THE MIND 4–7 (2008) (discussing how the intellectual property system creates and decentralizes the development of information and innovation).

19. *See* Hadfield, *supra* note 17, at 26 (arguing for harnessing the decentralized and market-based incentives of the private market for legal benefit).

provide a new means of public choice that can uncover useful information about how to design the law.

Proxy signaling represents a new way to think about social welfare analysis. Proxy analysis integrates collective private knowledge across varied entities and industries engaged in the innovation process. This collection of private and market knowledge about the relationship between innovation and patent law will be far greater than its individual constituent parts. This technique is based upon the same concept that lies behind the success of crowd-sourcing and futures markets, but applies the concept to the law.[20] This new approach for identifying socially optimal legal rules can be generalized in certain regards to solve complex trade-off questions in other legal domains. Many legal questions concern how to balance competing objectives in a complex environment where it is extremely difficult (and often impossible) to directly parse the relationship between social welfare and the law. For example, trying to optimize the trade-off between the harm of accidents and the cost of precaution, or the trade-off between the risk of unregulated financial markets and the cost of regulation. Though trade-off questions are highly contextual, and proxy analysis is not applicable in all legal fields, where it can be implemented it will provide a valuable new tool for improving the law.

This Article introduces proxy signal analysis using patent law as an example. Part I presents the challenge of balancing the trade-off between innovation incentives and exclusivity costs in patent law. Part II explicates the proxy signal methodology. Part III applies the proxy approach to patent law to identify which industries possess socially parallel innovation characteristics, and analyzes the signals produced by such industries to indicate how to achieve socially beneficial patent law. Analysis of the America Invents Act and recent Supreme Court decisions provide examples of the promise of proxy signal analysis. The Article concludes with a discussion of how proxy analysis can be refined to take into account distributional concerns and applied beyond patent law to other legal domains.

I. INNOVATION AND INTELLECTUAL PROPERTY LAW

Though proponents and opponents of patent reform disagree vigorously over how patent law affects innovation, they agree that patent law has a

20. *See, e.g.*, CASS R. SUNSTEIN, INFOTOPIA: HOW MANY MINDS PRODUCE KNOWLEDGE (2006); JAMES SUROWIECKI, THE WISDOM OF CROWDS: WHY THE MANY ARE SMARTER THAN THE FEW AND HOW COLLECTIVE WISDOM SHAPES BUSINESSES, ECONOMIES, SOCIETIES AND NATIONS (2004).

significant effect on innovation activity.[21] Without intellectual property protection, many potential innovators would have limited prospect of profit from their innovations, lowering incentives to innovate in the first instance, and lowering innovation overall. Intellectual property protection, however, is a dual-edged sword. Intellectual property rights not only provide incentives, they also limit access to patented products, reducing the distribution of innovation and the potential for future technological development.[22]

Patent law seeks to balance these competing trade-offs so as to maximize the net incentives to innovate for society.[23] The following sections consider this incentive versus exclusivity trade-off in greater depth and examine past attempts to identify the optimal balance between them.[24]

A. The Relationship between Patent Law and Innovation

Patent rights simultaneously provide an incentive to innovate and reduce access to current and future innovation. The former presents a potentially great social benefit; the latter a potentially great social cost. Patent law's incentives to innovate include not just the direct potential of supracompetitive profits, but also a number of other benefits that have been identified, including the opportunity for firms to signal their

21. Robert Cooter et al., *The Importance of Law in Promoting Innovation and Growth*, *in* RULES FOR GROWTH: PROMOTING INNOVATION AND GROWTH THROUGH LEGAL REFORM 3 (2011) (discussing empirical work showing that innovation is the most important factor of production for economic growth in the United States); Burk & Lemley, *supra* note 6, at 1576 ("Patent law is our primary policy tool to promote innovation.").

22. *See* David S. Abrams, *Did TRIPs Spur Innovation? An Analysis of Patent Duration and Incentives to Innovate*, 157 U. PA. L. REV. 1613, 1615 (2009); Robert P. Scotch & Richard R. Nelson, *On the Complex Economics of Patent Scope*, 90 COLUM. L. REV. 839 (1990); *see also* Bilski v. Kappos, 130 S. Ct. 3218, 3229 (2010) ("These [patent validity] limitations serve a critical role in adjusting the tension, ever present in patent law, between stimulating innovation by protecting inventors and impeding progress by granting patents when not justified.").

23. *See* Mayo Collaborative Servs. v. Prometheus Labs., Inc., 132 S. Ct. 1289, 1293–94 (2012); F.M. Scherer, *The Economic Effects of Compulsory Patent Licensing*, *in* NEW YORK UNIVERSITY MONOGRAPH SERIES IN FINANCE AND ECONOMICS 84 (1977) ("The problem of patent policy is to strike a balance: enough protection to sustain a desired flow of innovations, but not superfluous protection in view of alternate incentives for innovation and the social burdens monopoly power imposes."); JAMES BESSEN & MICHAEL J. MEURER, PATENT FAILURE: HOW JUDGES, BUREAUCRATS, AND LAWYERS PUT INNOVATORS AT RISK 11–12 (2008) (identifying the goal of maximizing net incentives to innovate).

24. This analysis is based on a widely-accepted utilitarian approach to patent law. BURK & LEMLEY, *supra* note 13, at 66–67 (2009) ("[T]heories of patent law based on moral right, reward, or distributive justice . . . are hard to take seriously as explanations for the actual scope of patent law.").

technological strength,[25] reduce transaction costs,[26] and price-coordinate.[27] If patent rights are too limited or too weak, potential innovators will face suboptimal incentives to invest resources and time in innovation-producing activities in the first instance.[28] Too little innovation will occur.

If patent rights are too expansive or too strong, however, potential innovators may face reduced incentives to innovate as well.[29] The grant of patent rights affects the value and feasibility of future innovation because it increases the cost of using the intellectual property of others, due to greater licensing and litigation expenses, and reduces incentives for follow-on improvement innovation, as any potential profit must now be shared.[30] In addition, greater propertization can increase the likelihood of property thickets and anticommons effects,[31] each creating costs that reduce the benefit of, and incentives for, innovation.

Somewhere between the extremes of no patent incentives and excessive barriers to access lies a level of propertization that can maximize the net incentives to innovate for society. While maximizing innovation by optimizing incentives is not precisely the same as maximizing the social welfare from innovation, it is a commonly used surrogate and sufficient for our purposes at this point.[32] In trying to optimize the trade-off between incentives and exclusivity, increases in the level of patent protection have

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25. Clarisa Long, *Patent Signals*, 69 U. CHI. L. REV. 625, 627–28 (2002).

26. WILLIAM M. LANDES & RICHARD A. POSNER, THE ECONOMIC STRUCTURE OF INTELLECTUAL PROPERTY LAW, 12–13, 318–25 (2003).

27. Douglas Lichtman, *Property Rights in Emerging Platform Technologies*, 29 J. LEGAL STUD. 615, 619–20 (2000).

28. BESSEN & MEURER, *supra* note 23, at 11.

29. Lab. Corp. of Am. Holdings v. Metabolite Labs., Inc., 548 U.S. 124, 126–27 (2006) (Breyer, J., dissenting) ("Sometimes *too much* patent protection can impede rather than 'promote the Progress of Science and useful Arts.'") (quoting U.S. CONST., art. I, § 8, cl. 8).

30. Jonathan M. Barnett, *Property As Process: How Innovation Markets Select Innovation Regimes*, 119 YALE L.J. 384, 407 (2009); Scotch & Nelson, *supra* note 22, at 839, 886–88; WILLIAM D. NORDHAUS, INVENTION, GROWTH, AND WELFARE: A THEORETICAL TREATMENT OF TECHNOLOGICAL CHANGE 76 (1969).

31. Carl Shapiro, *Navigating the Patent Thicket: Cross Licenses, Patent Pools, and Standard Setting*, 1 INNOVATION POL'Y & THE ECON. 119 (2000); Michael A. Heller & Rebecca S. Eisenberg, *Can Patents Deter Innovation? The Anticommons in Biomedical Research*, 280 SCI. 698, 698–700 (1998).

32. BESSEN & MEURER, *supra* note 23, at 11–12. Burk & Lemley, *supra* note 6, at 1597–99. The actual social welfare produced by innovation would be extremely difficult to measure. Abrams, *supra* note 22, at 1616. The goal of optimizing incentives also may have effects on the types of innovation that are incentivized. The conclusion of this Article discusses how the proxy signaling approach could be applied to broader questions of social value, including which kinds of innovation are incentivized. In addition to equitable considerations, maximizing the net incentives for innovation does not necessarily produce an optimally efficient system. Certain inefficiencies in a proprietary patent system, such as consumer dead weight losses from imperfect price discrimination and system administration expenses are not cured by optimal incentives.

two primary effects: they increase the incentives for innovators to innovate due to the potential for greater supracompetitive profits (thus increasing innovation activity), and simultaneously reduce incentives to innovate due to the grant of greater exclusive rights to others (thus reducing innovation activity). Starting from a point of low patent protection, so long as the marginal benefit from increased incentives outweighs the marginal cost of greater exclusionary rights, increasing patent protection will increase incentives to innovate on the whole. As patent rights increase, however, the marginal benefit of increased incentives will tend to get smaller (due to decreasing returns to scale),[33] while the marginal cost of exclusionary rights will tend to increase (due to the increased transaction costs of the network effects of greater exclusivity).[34] As a result, the relationship between a given level of patent protection and the corresponding net incentives or value of innovation produced by that level of propertization will have an inverted-U form, as represented in Figure 1.[35]

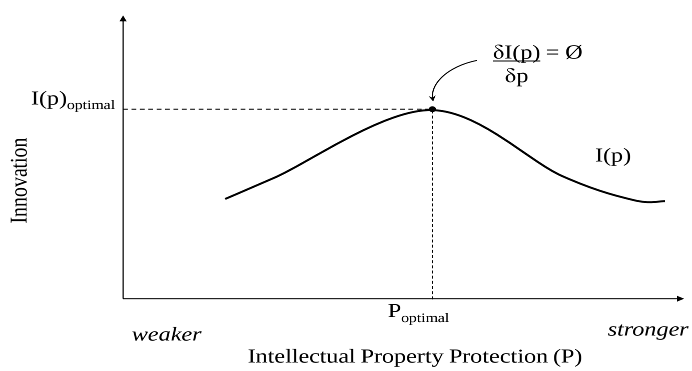

FIGURE 1. INTELLECTUAL PROPERTY LAW AND INNOVATION

33. *See* Brett M. Frischmann & Mark A. Lemley, *Spillovers*, 107 COLUM. L. REV. 257, 258 (2007) (noting the decreasing returns to scale of incentives).

34. *See* Barnett, *supra* note 30, at 411 (noting that as propertization levels increase, marginal transaction costs accelerate).

35. *See* Christopher A. Cotropia & James Gibson, *The Upside of Intellectual Property's Downside*, 57 UCLA L. REV. 921, 932–33 (2010) (presenting a similar approach); Jonathan Barnett, *Do Patents Matter? Empirical Evidence on the Incentive Thesis*, *in* HANDBOOK ON LAW, INNOVATION AND GROWTH 178 (Robert E. Litan ed., 2011) (presenting cross-country evidence for an inverted-U relationship); Nancy T. Gallini, *The Economics of Patents: Lessons from Recent U.S. Patent Reform*, 16 J. ECON. PERSP. 131, 136–39 (2002) (discussing empirical support for an inverted-U relationship).

Patent law regimes towards the left side of Figure 1 represent weaker propertization, commons approaches; regimes towards the right side represent stronger propertization, exclusivity approaches. Given any level of patent protection (P), the net incentives for innovation produced by that level of protection is denoted by the function I(p). The innovation function's maximum, labeled $P_{optimal}$ in Figure 1, represents the level of propertization that will maximize the total net incentives to innovate for society.[36] At $P_{optimal}$ the marginal benefit of increased incentives is exactly equal to the marginal cost of greater exclusion.[37] Beyond this "sweet spot," increases in the strength of patent protection tend to reduce net innovation incentives as the marginal cost of exclusionary rights outweighs the marginal benefit of increased incentives.[38]

In practice, we may never be able to allocate rights to precisely achieve the optimal level of incentives.[39] In fact, even if society found itself exactly at the optimal level, it is unlikely that we would know.[40] In the real world, laws can neither be set nor evaluated with the mathematical precision of a model. Even if we could achieve the optimal level momentarily, critical real world context, including innovation and industries, evolve dynamically, so the optimal target will change over time. Given this imperfect reality, the proxy signal methodology provides new means to achieve a first order understanding of where current law lies in relation to the optimum and how to move towards that optimum at a given time. As discussed later in the article, this approach can function dynamically so that as the optimum allocation of patent rights evolves, the signals obtained can evolve concurrently.

Figure 1 depicts the strength of patent protection as a single metric, displayed along its x-axis. In practice, any given level of patent protection is made up of a number of components, including the scope, duration, and

36. *See* Abrams, *supra* note 22, at 1615 (explaining that the "optimal patent term is the point at which the marginal benefit from increased innovation is exactly offset by the marginal cost of the deadweight loss created by the patent right.").

37. Stated mathematically, $\delta I(p)/\delta p = 0$ at $P_{optimal}$.

38. *See* Tim Wu, *Intellectual Property, Innovation, and Decentralized Decisions*, 92 VA. L. REV. 123 (2006) ("[I]ntellectual property grants are desirable to the extent that they encourage new product development at a reasonable cost.").

39. Because innovation is a public good, even defining the socially optimal level of incentives to innovate is a complex task. *See* BRETT FRISCHMANN, INFRASTRUCTURE: THE SOCIAL VALUE OF SHARED RESOURCES 53–57 (2012) (discussing challenges of pursuing optimality for public goods).

40. *See, e.g.*, B. Curtis Eaton & Richard G. Lipsey, *Product Differentiation*, *in* 1 HANDBOOK OF INDUSTRIAL ORGANIZATION 723, 760 (Richard Schmalensee & Robert Willig eds., 1989) (noting in a comparable market context that "we believe that we would be quite unable to recognize an optimum if we saw one").

enforceability of patent rights.[41] Sometimes, strengthening certain elements, while weakening others, could produce a socially superior patent regime, though it may be unclear whether such a regime represents "stronger" or "weaker" propertization. One can imagine a more complex, multi-dimensional version of Figure 1 that takes into account these different components, in which the innovation function is no longer a two-dimensional curve, but a multi-dimensional form. For purposes of initial explanation, it is convenient to conceptualize patent propertization strength as ordered along a single dimension, considering each point along the axis to represent a set of patent rights, involving, for example, particular scope and duration of rights.[42] This simplification is for ease of introduction only, and is not necessary for proxy signal analysis.[43]

Finally, although Figure 1 happens to display the optimal level of propertization towards the middle of the function, proxy analysis makes no *a priori* assumptions about whether a highly commons-oriented or highly propertized legal regime is preferable, or whether something in between might be better. Similarly, the proxy approach is also agnostic about where existing legal regimes lie in relation to the social optimum. Whether current patent law provides too strong or too weak propertization, for example, the same method can be applied to produce signals concerning how to best refine the law.[44]

B. Conventional Approaches to Optimizing Patent Rights

Academics and other experts in many fields have spent decades trying to understand where the sweet spot of patent protection lies in order to

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41. *See* Cotropia & Gibson, *supra* note 35, at 932 (making this point with respect to several aspects of intellectual property protection); John M. Golden, *Principles for Patent Remedies*, 88 TEX. L. REV. 505, 526 (2010) (listing a number of components of patent rights). As a formal matter, the scope of patent rights can be defined to include both the validity standards and enforceability of patent rights, leaving two primary dimensions of propertization: the scope and duration of rights. Suzanne Scotchmer, *Standing on the Shoulders of Giants: Cumulative Research and the Patent Law*, 5 J. ECON. PERSPECTIVES 29, 38 (1991).

42. *See* Cotropia & Gibson, *supra* note 35, at 933 (making the same assumption). In mathematical terms, $I(p) = I(p_a, p_b, p_c \ldots)$, where p_a might represent the scope of patent rights, p_b the duration of patent rights, p_c the enforceability of patent rights, and so on.

43. Applying the proxy signal approach to multi-component patent rights regimes requires identifying localized maxima within a multi-dimensional set of rights. Because the proxy approach depends on identifying industries that mirror social preferences, however, application to a multi-dimensional set of rights is not significantly more complicated than the one-dimensional approach described here.

44. It is theoretically possible that patent rights trade-offs could present a multi-peaked social value function, which would require modification of the proxy signal method introduced here, though this possibility seems unlikely in practice.

achieve the optimal level of incentives. There have been many ambitious and creative attempts to solve this complex empirical problem. Past and ongoing efforts include advanced conceptual frameworks,[45] complex theoretical models,[46] comparisons of innovation across jurisdictions with differing intellectual property protection,[47] and studies of changes in innovation due to changes in intellectual property laws over time.[48] Though these approaches include many extraordinarily sophisticated endeavors, each is unable to identify the optimal level of patent protection for at least one (and usually multiple) of the following reasons: (1) they cannot sufficiently take into account all the real world factors influencing innovation and incentives,[49] (2) they cannot identify or control for the pertinent factors that influence innovation in real world studies,[50] or

45. *E.g.*, Heller & Eisenberg, *supra* note 31; Merges & Nelson, *supra* note 30; Scotchmer, *supra* note 41; Edmund W. Kitch, *The Nature and Function of the Patent* System, 20 J.L. & ECON. 265, 276–77 (1977).

46. *E.g.*, James Bessen & Eric Maskin, *Sequential Innovation, Patents, and Imitation*, 40 RAND J. ECON. 611 (2009); Robert Hunt, *Patentability, Industry Structure, and Innovation*, 52 J. INDUS. ECON. 401 (2004); Partha Dasgupta & Joseph E. Stiglitz, *Uncertainty, Industrial Structure and the Speed of R&D*, 11 BELL J. ECON. 1 (1980); NORDHAUS, *supra* note 30.

47. *E.g.*, Petra Moser, *How Do Patent Laws Influence Innovation? Evidence from Nineteenth-Century World Fairs*, 95 AM. ECON. REV. 1214 (2005); Josh Lerner, *Patent Protection and Innovation over 150 Years* (Nat'l Bureau of Econ. Research, Working Paper No. 8977, 2002), *available at* http://www.nber.org/papers/w8977; ERIC SCHIFF, INDUSTRIALIZATION WITHOUT NATIONAL PATENTS: THE NETHERLANDS, 1869–1912, SWITZERLAND, 1850–1907 (1971).

48. *E.g.*, Aaron A. Kesselheim, *Using Market-Exclusivity Incentives to Promote Pharmaceutical Innovation*, 363 NEW ENG. J. MED.1855 (2010); Abrams, *supra* note 22; James E. Bessen & Robert M. Hunt, *An Empirical Look at Software Patents*, 16 J. ECON. & MGMT. STRATEGY 157 (2007); Moser, *supra* note 47, at 1216; Mariko Sakakibara & Lee G. Branstetter, *Do Stronger Patents Induce More Innovation? Evidence from the 1988 Japanese Patent Law Reforms*, 32 RAND J. ECON. 77 (2001); Mark A. Lemley, *An Empirical Study of the Twenty-Year Patent Term*, 22 AIPLA Q.J. 369 (1994).

49. *See* Abrams, *supra* note 22, at 1616–25 (discussing the difficulty of measuring innovation); Bessen & Maskin, *supra* note 46, at 614–27 (providing one of the most sophisticated economic models to date, but noting inaccurate assumptions that no firms own patents *ex ante* and that the social value of an invention is known); Scotchmer, *supra* note 41, at 32–40 (discussing the difficulty and lack of information for evaluating the pioneer versus improver balance of rights in conceptual models); Peter S. Menell, *A Method for Reforming the Patent System*, 13 MICH. TELECOMM. & TECH. L. REV. 487, 488–89 (2007) (providing a laundry list of some of the factors that would need to be taken into account in an economic model of optimizing patent protection). Simplifying assumptions are, in fact, one of the hallmarks and benefits of economic modeling. *See* Colin F. Camerer, *Behavioral Economics*, *in* WORLD CONGRESS OF ECONOMETRIC SOCIETY PROCEEDING 6 (T. Persson ed., 2011), *available at* http://www.hss.caltech.edu/~camerer/index.htm.

50. *See* WILLIAM J. BAUMOL, THE FREE-MARKET INNOVATION MACHINE: ANALYZING THE GROWTH MIRACLE OF CAPITALISM 296 (2002) (noting difficulty with measuring or establishing the cause of innovation); SCHIFF, *supra* note 47, at 43, 51, 102–06 (noting problems with measuring innovation and with comparing real world studies across time or jurisdiction); Abrams, *supra* note 22, at 1615–19, 1640–41 (noting problems with evaluating exogenous effects on innovation and with the data used to measure innovation); LERNER, *supra* note 47, at 7, 28 (noting problems with data used to measure innovation); G. M. PETER SWANN, THE ECONOMICS OF INNOVATION: AN INTRODUCTION 35–36 (2009) (describing limitations of various approaches to measuring innovation).

(3) they consider only a limited area of innovation.[51] Though we have learned much about innovation and patent law from these efforts, including a variety of data that is relied upon in the following analysis, our understanding of the relationship between innovation and law remains frustratingly inconclusive.[52]

This uncertainty can have significant ramifications for intellectual property policy. Though the political economy of intellectual property law, as with other areas, is difficult to parse, the lack of an objective understanding of the relationship between patent law and innovation likely makes it easier for special interest lobbying to hold even greater sway over lawmaking than it otherwise would.[53] Where most industry players unify behind a particular change, as has been the case in ratcheting up copyright protection over time, such changes tend to become law.[54] Where industry

51. *See, e.g.*, Abrams, *supra* note 22 (concentrating on the pharmaceutical industry); Kesselheim, *supra* note 48 (same); Rosemarie Ham Ziedonis, *Don't Fence Me In: Fragmented Markets for Technology and the Patent Acquisition Strategies of Firms*, 50 MGMT. SCI. 804 (2004) (semiconductor industry); Bessen & Hunt, *supra* note 48, at 157 (software industry).

52. ROBERT P. MERGES, JUSTIFYING INTELLECTUAL PROPERTY 2 (2011) (referring to balancing the costs and benefits of intellectual property as "impossibly complex"); Abrams, *supra* note 22, at 1641 ("Understanding the incentive effects of patent protection is a core issue in intellectual property scholarship, about which almost nothing is currently known."); Burk & Lemley, *supra* note 6, at 1581 ("Rather than resolve the debate over how well the patent system works, [legal and economic scholarship] has painted a more complex picture."); Roberto Mazzoleni & Richard R. Nelson, *Economic Theories about the Benefits and Costs of Patents*, 32 J. ECON. ISSUES 1031, 1051 (2000) (conducting a literature review of patent analysis covering forty years and concluding, "our lack of knowledge here clearly limits our ability to analyze intelligently the current pressing issues of patent reform"); George L. Priest, *What Economists Can Tell Lawyers About Intellectual Property*, 8 RES. L. & ECON. 19 (1986) ("[I]n the current state of knowledge, economists know almost nothing about the effect on social welfare of the patent system or of other systems of intellectual property."); FRITZ MACHLUP, STUDY OF THE U.S. SENATE SUBCOMMITTEE ON PATENTS, TRADEMARKS & COPYRIGHTS: AN ECONOMIC REVIEW OF THE PATENT SYSTEM 79–80 (1958) ("No economist, on the basis of present knowledge, could possibly state with certainty that the patent system, as it now operates, confers a net benefit or a net loss upon society.").

53. WILLIAM M. LANDES & RICHARD A. POSNER, POLITICAL ECONOMY OF INTELLECTUAL PROPERTY LAW 25 (2004), *available at* http://www.pralmeida.org/04Temas/11academia/05materiais/07LandesPosnerPolEcIntProp.pdf (using public choice theory to explain how industry-group pressure may ratchet up intellectual property protection despite uncertainty as to whether an increase is socially beneficial); Robert P. Merges, *One Hundred Years of Solicitude: Intellectual Property Law, 1900–2000*, 88 CAL. L. REV. 2187, 2235–36 (2000) (discussing the heavy industry interest group role in drafting and passing intellectual property legislation); William F. Patry, *Copyright and the Legislative Process: A Personal Perspective*, 14 CARDOZO ARTS & ENT. L.J. 139, 141–42 (1996) (discussing the heavy industry role in copyright legislation).

54. *See* Shyamkrishna Balganesh, *The Pragmatic Incrementalism of Common Law Intellectual Property*, 63 VAND. L. REV. 1543, 1546 (2010); LANDES & POSNER, *supra* note 53, at 25; GARY D. LIBECAP, CONTRACTING FOR PROPERTY RIGHTS 27 (1989) (noting that the political influence of industry groups depends in part on their homogeneity); *see also* Jay P. Kesan & Andres A. Gallo, *The Political Economy of the Patent System*, 87 N.C. L. REV. 1341 (2009) (discussing the influence of lobbying on patent legislation).

players are divided, as has been the case in the patent reform debates, there is often legislative deadlock on the change.[55] In neither case is there any significant legitimate sense concerning whether the change is good for innovation or society overall.[56] The result is often inefficient law. Or, at least, we think it is. Without understanding the relationship between innovation and law in the first instance, we cannot know whether the law is socially optimal or not. This is hardly a model of public choice.

The inability of existing analysis to resolve the relationship between innovation and law is an almost necessary consequence of using conventional law and economics approaches to try to evaluate this interaction directly. Because the relationship is so complex and contextual, it is impossible to take all pertinent factors into account or to convey lessons from one situation and time to another. [57] This project provides an alternate perspective to better investigate these long considered problems, developing different means to parse the seemingly insurmountable challenge of the complexity of the real world interaction between innovation and intellectual property law.

II. PROXY SIGNALS: CAPTURING PRIVATE INFORMATION FOR PUBLIC BENEFIT

Proxy signal analysis presents a new mechanism for public choice by introducing an original empirical framework to evaluate where current doctrine stands in relation to socially preferable legal rights. Most prior law and economics efforts to analyze rights balancing questions, including those discussed above, take a top-down approach. These strategies attempt to directly assess the social welfare produced by legal doctrine so as to identify the optimal level of rights and mold the law accordingly. Other efforts use a bottom-up approach, attempting to aggregate private preferences in order to calculate their social combination. Both prevailing law and economics strategies effectively try to identify the relationship between social welfare and the law directly.

Proxy signal analysis provides a third way to conduct law and economic analysis. This approach carefully selects industry proxies whose

55. *See, e.g.*, Balganesh, *supra* note 54, at 1592–93; BURK & LEMLEY, *supra* note 13, at 100–02.

56. LIBECAP, *supra* note 54, at 11 (discussing rent-seeking in bargaining over property rights and the lack of attention to overall social effects).

57. *See* MACHLUP, *supra* note 52, at 79–80 ("The best [any economist studying the patent system] can do is to state assumptions and make guesses about the extent to which reality corresponds to these assumptions.").

private preferences are expected to structurally mirror the actual relationship between the law and social welfare. The proxy signal method presents means to uncover private market information that indirectly signals socially superior legal regimes. This technique is based on the realization that in certain contexts public lawmakers can more accurately evaluate industry characteristics pertinent to a desired social trade-off than they can evaluate social welfare directly. This situation will occur where public entities possess significant information concerning characteristics that shape industry preferences, but lack direct information concerning how to best promote an underlying social policy. Such situations arise in many circumstances for a variety of reasons, including from the informational asymmetry between the public sector and private industry, a lack of accurate pricing signals for the provision of public goods, or other circumstances where the market fails to provide accurate information concerning the social demand for laws. This indirect proxy approach uses the actions of real world actors who possess desired information to detect signals that can help shape the law. Rather than succumbing to the difficulty in much economic analysis of trying to fit an economic model to the complexity of the real world, the technique presented here takes advantage of the brilliant intricacy of real world variation as a tool. The following sections present the conceptual framework for proxy signal analysis.

A. The Externalities of Innovation

Like most private activities, the private economic value and the social economic value of innovation diverge. This divergence is the result of externalities. Because innovators generally cannot capture the full social value of their innovation, innovation produces positive externalities. Conversely, because innovators often need not pay the full cost of exclusivity produced by patenting an innovation, innovation can produce negative externalities.

Positive externalities refer to benefits produced by a private individual's activities for which the individual is not fully compensated.[58] In the case of innovation, positive externalities are legion. The positive externalities, or spillovers, of innovation include third-party benefits from the chance to improve upon an innovation (and profit thereby), the opportunity for others affiliated with innovation to learn from an

58. Frischmann & Lemley, *supra* note 33, at 262.

innovation and transfer that know-how to other projects, and the benefit of consumer surplus for consumers who are able to acquire innovation products at a price lower than their absolute willingness to pay.[59] As a result of these positive externalities, innovators often cannot privately reap the full value of innovation, and consequently may not be incentivized to engage in the socially optimal level of innovation-producing activity in the first instance.[60]

Conversely, negative externalities refer to costs imposed by a private individual's actions for which the individual does not have to pay.[61] Environmental pollution is a classic example of a negative externality. Polluters often do not pay the full health, medical, and environmental costs of pollution, and therefore may engage in more polluting activity than is socially optimal.[62] Negative externalities also exist for innovation as a result of patent protection. Most significantly, innovators do not have to pay the full exclusivity costs produced by their patent rights. Patent owners are largely immune from the limitations on access and restraints on future innovation produced by their patent rights, including those produced by their patents' contribution to property thickets, anticommons problems, and uncertainty, such as in the scope of the patent rights.[63] As a result of negative externalities, innovators and patent owners may engage in greater exclusionary-producing activity than is socially optimal.[64]

Due to positive and negative innovation externalities, innovators usually do not face socially optimal incentives to innovate.[65] Were a

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59. FRISCHMANN, *supra* note 39, at 303–04; Frischmann & Lemley, *supra* note 33, at 268; James Bessen & Michael J. Meurer, *Lessons for Patent Policy from Empirical Research on Patent Litigation*, 9 LEWIS & CLARK L. REV. 1, 6 (2005).

60. Frischmann & Lemley, *supra* note 33, at 262; BESSEN & MEURER, *supra* note 59, at 6. Of course, individuals innovate for a variety of reasons, including intellectual curiosity and challenge, and personal or professional respect or reward. *See, e.g.*, Roberta R. Kwall, *Inspiration and Innovation: The Intrinsic Dimension of the Artistic Soul*, 81 NOTRE DAME L. REV. 1945, 1946 (2006). Analyzing the difference between private value and social value due to externalities requires taking these effects into account.

61. Frischmann & Lemley, *supra* note 33, at 262.

62. Adam B. Jaffe et al., *A Tale of Two Market Failures: Technology and Environmental Policy*, 54 ECOLOGICAL ECON. 164, 165 (2005).

63. *See* Robert M. Hunt, *When do More Patents Reduce R&D?*, 96 AM. ECON. REV. 87, 90 (2006) (developing a model of the effect on research and development of changes in patent law); Michael W. Carroll, *One Size Does Not Fit All: A Framework for Tailoring Intellectual Property Rights*, 70 OHIO ST. L.J. 1361, 1394 (2009) ("[A]llocative inefficiency in intellectual property law potentially imposes a far more significant social cost than it does with respect to tangible property.").

64. Mark A. Lemley, *Ex Ante Versus Ex Post Justifications for Intellectual Property*, 71 U. CHI. L. REV. 129, 144 (2004); Lichtman, *supra* note 27, at 616–17.

65. *See* Frischmann & Lemley, *supra* note 33, at 268 (discussing the effect of externalities on incentives). Just because externalities affect innovation incentives does not mean that the optimal level of incentives necessarily requires internalizing all externalities. *Id.*

potential innovator to face zero net externalities with respect to innovation, meaning the potential innovator would be able to capture the full benefit from and have to pay the full cost of a particular innovation, such an innovator would face socially optimal incentives to innovate. In effect, firms that attempt to develop and utilize necessary innovation in-house are sometimes trying to produce this effect internally.[66] The existence of externalities, however, will mean that in most cases the private trade-offs between the incentives and exclusivity of innovation will diverge.

There is no reason to expect that the divergence between private and social innovation trade-offs will be the same for all private entities or that they will remain constant across different levels of patent protection. To the contrary, because greater or lesser protection is expected to affect positive and negative innovation externalities in different manners, such as by creating anticommons or property thicket effects, the relationship between private and social trade-offs will vary across entities and across different levels of propertization. Thus, the function that identifies a private entity's net innovation incentives for any given level of patent protection will not only be located at a different level than society's innovation function in Figure 1, but also will display a different structure and will likely have its maximum at a different level of protection.

B. Private Industry Preferences

From a societal perspective, an increase in patent rights simultaneously produces a marginal incentive to innovate due to the increased potential value of a patent reward and a marginal disincentive to innovate due to the increased exclusionary effects of stronger patent rights held by others. The relative size of these marginal changes dictates whether any given change in rights is socially beneficial.[67]

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66. Historic examples of such efforts include famous laboratories at Bell Labs, DuPont, and 3M. *See* Erin Shinneman, *Owning Global Knowledge: The Rise of Open Innovation and the Future of Patent Law*, 35 BROOK. J. INT'L L. 935, 940–41 (2010) (discussing the system of closed innovation at large corporate research laboratories, including Bell Labs, in the twentieth century); Stuart M. Benjamin & Arti K. Rai, *Fixing Innovation Policy: A Structural Perspective*, 77 GEO. WASH. L. REV. 1, 14 (2008) (noting breakthrough innovation at in-house research laboratories in "an earlier era"); THOMAS P. HUGHES, AMERICAN GENIUS: A CENTURY OF INNOVATION AND TECHNOLOGICAL ENTHUSIASM 1870–1970 7 (2d ed. 2004) (discussing the rise of industrial research laboratories, including ones at General Electric, Du Pont, General Motors, and Bell Telephone). It is likely far harder to accomplish such a system today due to the greater need to use other firms' intellectual property.

67. Hunt, *supra* note 46, at 415.

The analysis of rights from a private perspective is similar, although the basis for the preferences is slightly different. Private individuals will perceive a marginal incentive to innovate from an increase in patent rights, due to the opportunity for greater profit from stronger rights. Private individuals will also perceive a marginal cost from a strengthening of patent rights due to a corresponding increase in the cost of patent inputs that are owned by other entities and due to rent dissipation caused by increased competition between protected technologies or future innovation. Private actors will support increasing patent protection to the extent they perceive that their marginal opportunity to profit from increased rights will exceed the marginal cost of competing patent owners obtaining stronger rights.[68] The magnitude and direction of the marginal effects of changes in patent protection on private incentives will vary from society's for any given change due to externalities.

Because most innovators do not expect to be one-time players in innovation fields, they will be cognizant of the potential negative impact of stronger propertization and will seek to maximize the private value of a cumulative stream of innovation over time.[69] This will be particularly true if we shift from private individuals to firms and to an industry-wide perspective. To an even greater extent than individuals, firm and industry preferences will routinely take into account both the benefits and the costs of lesser or greater levels of patent protection. It is often competing firms within one's own industry that most directly experience the negative exclusivity costs of increases in the strength of patent rights. Consequently, industry preferences for patent rights will seek a level of protection that optimizes incentives for the industry.[70]

Industries, of course, are not monolithic entities, but are made up of a collection of firms that each have their own patent preference functions. For purposes of introducing the proxy approach, the analysis begins by focusing on industries as characterized by their dominant firms, which are the entities that will most strongly direct the industry's advocacy.[71] This

68. *See* PROPERTY RIGHTS: COOPERATION, CONFLICT, AND LAW 5 (Terry L. Anderson & Fred S. McChesney eds., 2003) (discussing that private market entities will want to increase propertization up to the point where the marginal gain of increased rights equals the marginal cost of the increased rights).

69. This is one context where patent law may diverge from other domains. While most entities can expect to end up on both sides of patent rights ownership disputes, in other contexts this is not the case. Certain entities will expect to be torts defendants more often than plaintiffs, or environmental polluters more often than environmental protectors. This effect is taken into account in the analysis. *See infra* Part III.

70. Barnett, *supra* note 30, at 388.

71. Kesan & Gallo, *supra* note 54, at 1362–63.

simplification is relaxed later in the article to achieve a more fine-grained examination and more precise signals.[72]

Just because private industries are expected to have patent preference functions that seek optimal innovation incentives for their industry does not mean that the shape of the private industry function will reflect the shape of the social innovation function. Positive and negative externalities from innovating and patenting will cause industry patent preference functions to differ from the social preference function, sometimes greatly. If, for example, increasing patent protection would allow an industry to profit on net at the expense of those outside the industry, such as by increasing wealth transfer or dead weight losses, the industry will prefer stronger protection, even though such stronger propertization may be socially detrimental on net due to society-wide increased exclusivity costs.

Industry operators, including industry advocacy organizations and dominant firms within an industry, will seek to maximize the private value of patent protection for the industry, without regard to the effect of such a level of protection on society as a whole.[73] This will lead various industries to advocate for patent rights that are either stronger or weaker than the socially optimal level, depending on the industry. Figure 2 adds a pair of hypothetical private industry preference functions to the original society-wide preference function of Figure 1. An industry that can benefit from strong patent rights to extract large monopoly profits, even if this reduces overall innovation incentives for society, will advocate for stronger patent protection than is socially optimal. Industry A in Figure 2 presents an industry of this type. The private value that Industry A derives from any given level of patent protection is denoted by the function $I_A(p)$. Conversely, an industry that can piggyback on others' innovation in order to profit, or that faces extreme risks of property thickets, may favor weaker patent rights than those that would maximize incentives from a societal perspective. Industry B in Figure 2 presents this possibility; its private value function is denoted by $I_B(p)$.[74]

72. *See infra* Part III.F.2. Some research indicates that we may want to particularly concentrate on smaller firms and start-ups to optimally promote innovation. Golden, *supra* note 41, at 545–46.

73. *See* LIBECAP, *supra* note 54, at 4 ("In bargaining over creating or modifying property rights, the stands taken by various bargaining parties, including private claimants, . . . will be molded by their *private* expected gains."); *see* FRISCHMANN, *supra* note 39, at 72–78 (discussing the difference between social and private demand preferences).

74. The private innovation profiles are graphed to generally lie below the social value patent function because an industry generally cannot produce greater innovation than society as a whole. *See* Frischmann & Lemley, *supra* note 33, at 257, 259 ("There is abundant evidence that the social value of innovations far exceeds the private value."); Michael J. Meurer & Katherine J. Strandburg, *Patent Carrots and Sticks: A Model of Nonobviousness*, 12 LEWIS & CLARK L. REV. 547, 549 (2008) (noting

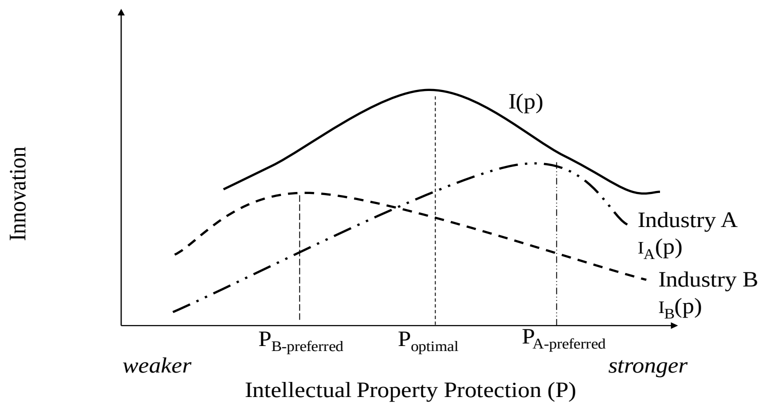

FIGURE 2. INDUSTRY PREFERENCES FOR INTELLECTUAL PROPERTY PROTECTION

Private industry preferences for patent protection will be self-interested, seeking to maximize the private value of innovation for the industry. As a result, private industry advocacy concerning patent law generally does not provide a useful signal concerning the optimal level of patent protection for society as a whole. That said, private patent law advocacy is based on an industry's internal information concerning how to optimize innovation and intellectual property rights for the industry, information that is far superior to anything that public policy makers have at their disposal.[75] Current intellectual property law is based in part on this premise, that the private sector has better information in these regards than the public. If the government had the same—or better—information as the private sector, patent and copyright law would be unnecessary, as the government could select the research and innovation activity that would most benefit society and then make such innovation available at cost.

As private industry has the best information concerning the relationship between innovation and intellectual property law, it would be highly valuable if public policy makers could acquire and leverage this information. Any signals that can be accurately drawn from private industry activity will have the substantial benefit of great financial and

that it "is realistically nearly always the case" that "the social value of research projects substantially exceeds their private value").

75. Carroll, *supra* note 63, at 1374.

informational resources. The following section explains how proxy analysis can be used to take advantage of private industry advocacy as a signal to identify socially advantageous levels of patent protection.

C. Leveraging Innovation Market Dynamics

Recent debates over patent reform make evident that different industries interact with the patent system in widely disparate manners. Conflict over proposed patent reform legislation that has been introduced in Congress in each of the past six years provides a prominent example. The software and information technology industries,[76] for example, have argued vociferously for patent reform in order to reduce the strength of patent protection that they see as stifling innovation and technological advance in their fields.[77] The pharmaceutical and biotechnology industries, on the other hand, have argued just as strenuously that strong patent protection is critical to the survival of their industries and to continued technological innovation.[78] One industry's paradise of strong patent protection is another industry's prison of inefficient barriers to innovation.

Given the analysis above, these stark differences are not surprising. Industries vary significantly in their manner and form of innovation, the relationship between such innovation and the patent system, and the market structure within the industry. All of these factors can have significant effects on how an industry interacts with the patent system, and therefore on which aspects of the patent system an industry favors or finds distasteful.[79] In economic terms, each of these factors affects the particular externalities that an industry faces in relation to patent protection, and therefore will affect the shape of the industry's private patent preference function.[80]

76. Neither software nor information technology are precisely defined industries. Firms in many industries develop software. For purposes of this article, the software industry includes those firms whose primary line of business involves developing and commercializing software applications. Microsoft is an archetypal example. Information technology could be defined broadly to include the Internet, telecommunications, computers, software, semiconductors, and other fields, or more narrowly. For purposes of this Article, the information technology industry refers to firms who primarily provide information services, but do not fall within one of the other industries that are separated for analysis here (see Table 1). Internet companies are a good example.

77. BURK & LEMLEY, *supra* note 13, at 100–02.

78. *Id.*

79. *See* Kesan & Gallo, *supra* note 54, at 1351–53 (discussing how the type of technology a company produces and company size will affect its patent system preferences).

80. *See* Dietmar Harhoff, *R&D Spillovers, Technological Proximity, and Productivity Growth—Evidence from German Panel Data*, 52 SCHMALENBACH BUS. REV. 238 (2000) (finding that positive externalities vary by industry).

Because industry patent preferences vary, as indicated in Figure 2, the relationship between different industries' private incentive versus exclusivity trade-offs at a given level of patent protection, and the social trade-offs at that same level of protection, will also vary. This variation is why industries line up on opposite sides of various patent reform debates. Industry A in Figure 2, for example, will advocate for a $P_{A\text{-preferred}}$ level of protection, while Industry B will advocate for a $P_{B\text{-preferred}}$ level of protection. If a particular patent law change is proposed, each industry will evaluate the effect of that change relative to the status quo, and advocate for or against the change based on their private preferences.[81]

Any relationship between private industry advocacy and whether a particular patent reform is socially beneficial is entirely accidental from the industry's point of view. Accidental, however, does not mean random or unknowable. Some industries' private propertization preference functions will be more similar to the social function than others. Figure 3 adds a third industry to the earlier analysis, Industry C, which happens to present a preference profile that is more similar to the social profile than either Industry A or Industry B. As a result of Industry C's more similar profile, Industry C's optimal level of patent protection ($P_{C\text{-preferred}}$) will be closer to the socially optimal level of protection than either Industry A or Industry B. This will mean that, in most cases, Industry C will be more likely to advocate for socially preferable levels of patent protection than either Industry A or Industry B. This is not because Industry C is any more socially altruistic than Industry A or B, but rather it is a side-effect of the form of Industry C's private innovation preference profile.

Figure 3 reveals that the quantitative size of the gap between an industry's innovation profile and the social profile is not relevant to whether the industry will tend to advocate for or against socially preferable patent rights. Rather, what matters are the form of the patent preference function and the position of the maximum of that function. It is not the size of the industry, but the form of its preferences. As long as the maxima of the private industry and social preference functions lie at relatively similar levels of propertization and the form of the functions are comparable across various levels of patent protection, then a private

81. *See* LIBECAP, *supra* note 54, at 11 ("In contracting over proposed property rights, the bargaining stands taken by the various parties depend on how they view their welfare under the new arrangement relative to the status quo.").

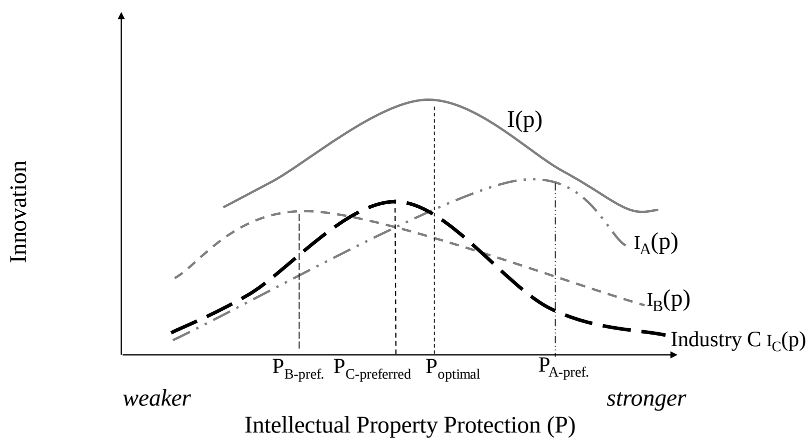

FIGURE 3. PRIVATE INDUSTRY PREFERENCES AND INNOVATION

industry will tend to desire a socially beneficial level of patent rights.[82] The question thus becomes whether we can identify the Industry C's of the world.

Proxy signal analysis provides a way to do so. Critical to the signal methodology, the structure of private industry preference functions are not random. Rather, the private preference profiles are the result of industry characteristics concerning the relationship between innovation in the industry and the patent system. By identifying industry characteristics that tend to produce a closer correspondence between the structure of an industry's preference function and the social function, it is possible to leverage private industry advocacy concerning patent protection as a valuable proxy signal concerning whether such protection levels are actually socially beneficial. As discussed in the following part, identifying industry characteristics that produce the desired social correspondence is both a feasible undertaking and a more manageable task than prior efforts to identify optimal levels of patent protection directly.

82. Stated mathematically, it is not relevant whether $I(p) \approx I_i(p)$ for any given level of patent protection for any given industry, but whether $\delta I/\delta p \approx \delta i_i/\delta p$ in general, and whether the point, $P_{optimal}$, at which $\delta I/\delta p = 0$ is approximately equal to the point at which $\delta i_i/\delta p = 0$.

III. PRIVATE INDUSTRY PROXY SIGNALS

This part applies the new proxy signal framework to the problem of identifying the optimal level of patent protection for society. The discussion will provide a functional road map for how proxy signals can work, and analyze such signals for patent law. Due to space constraints, the instant examination is not fully comprehensive at this stage, but introduces the complete framework and indicates how it applies in various currently contentious patent debates, including whether or not the America Invents Act and recent Supreme Court decisions are expected to increase net incentives to innovate. Following the initial exposition of proxy signal analysis is a discussion of how it can be refined to take into account variation within industries and to function dynamically, as well as clarifications and responses to anticipated questions.

A. Industry Variation in Innovation

The manner of innovation in an industry, the relationship between innovation in the industry and the intellectual property system, and firm and market structure within an industry all vary from industry to industry. These differences cause different industries to interact with the patent system in widely different manners, and consequently cause different industries to have different patent law preferences.

Patent and copyright law, however, primarily take a one-size-fits-all approach to intellectual property protection.[83] The same patent law generally applies whether one patents a better mousetrap, component of a cell phone, or new nanobiotechnological process.[84] The same copyright law generally applies to literary works, musical compositions, and artistic creations.[85] Some commentators support unitary intellectual property regimes, arguing that there are sufficient benefits to uniform patent and copyright law that outweigh the potential costs of differentiating across industries.[86] Other scholars and analysts consider industry variation to be a

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83. Mayo Collaborative Servs. v. Prometheus Labs., Inc., 132 S. Ct. 1289, 1293–94 (2012); Burk & Lemley, *supra* note 6 at 1576–77; Clarisa Long, *Our Uniform Patent System*, 55 FED. LAW. 44, 47–49 (2008).

84. 35 U.S.C. § 101 (2000). There are certain ways in which patent rights do vary by industry, most relatively minor. *See* Carroll, *supra* note 63, at 1390.

85. 17 U.S.C. § 106 (2000).

86. *E.g.*, Long, *supra* note 83, at 49 ("The same might be said of a unitary patent system that Winston Churchill famously said about democracy: It's the worst form of patent system, except for all the others that have been tried."); R. Polk Wagner, *Of Patents and Path Dependency: A Comment on Burk and Lemley*, 18 BERKELEY TECH. L.J. 1341 (2004). Long-standing United States policy and extant international treaties governing intellectual property law also indicate a largely unitary regime.

problem for intellectual property law, as it indicates that different intellectual property laws would optimize incentives to innovate in different industries.[87] Without weighing in on this robust debate, the analysis here accepts the unitary approach as a functional given to introduce the proxy approach, and subsequently discusses how proxy analysis could be applied in a differentiated patent regime.

Proxy analysis begins with a study of the particular industry characteristics that cause industries to encounter innovation and the patent system differently. These different characteristics cause industries to vary in their patent preferences, both functionally and politically in their advocacy. After examining the industry innovation characteristics, the analysis evaluates how each characteristic affects the relationship between private and social innovation preferences. This understanding is then used to evaluate which industries provide the most socially equivalent proxy signals. Though some may bristle at a perception of effectively privileging certain industry preferences, either because of discomfort with a focus on private preferences at all or because of an inferred favoritism for certain industries, it is critical to recognize that industries are selected not to promote or privilege any industry itself, but to utilize industry preferences to reveal private information concerning what is best for innovation for public society as a whole.

B. Industry Innovation Characteristics

Industry variation in patent preferences derives from a number of different innovation characteristics. Evaluating these innovation characteristics presents empirical questions on which we possess substantial data. The industry characteristics that influence patent preferences can be roughly divided into three categories: (1) variation in the characteristics of the primary technology in which the industry

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Hearing on "Bridging the Tax Gap" Before the Senate Comm. on Finance, 108th Congress (2004) (Statement of Nicholas Godici, Comm'r for Patents, U.S. Patent and Trademark Office) (stating that the patent system is "technology neutral and there shall be no disparate treatment for different categories of inventions"); Marrakesh Agreement Establishing the World Trade Organization, Annex 1C: Agreement on Trade-Related Aspects of Intellectual Property Rights, April 15, 1994, 1867 U.N.T.S. 154.

87. *E.g.*, BURK & LEMLEY, *supra* note 13, at 167 (contending that "a patent system that is not flexible enough to account for . . . industry difference is unlikely to survive"); Carroll, *supra* note 63, at 1366, 1389, 1406 (stating that "as a normative matter, intellectual property rights should be tailored to reduce uniformity cost" and discussing when such tailoring should occur); Glynn S. Lunney, Jr., *Patent Law, the Federal Circuit, and the Supreme Court: A Quiet Revolution*, 11 SUP. CT. ECON. REV. 1, 6 (2004) (arguing for certain variation in intellectual property protection so as to "limit application of a uniform system of intellectual property rights to 'similar' innovative products").

innovates, (2) variation in the characteristics of patenting in the industry, and (3) variation in the market structure of the industry. These innovation characteristics are analyzed below with respect to nine of the heaviest patenting industries in the United States: biotechnology, pharmaceuticals, software, semiconductors, medical devices, telecommunications, mechanical, financial, and information technology. For ease of introduction, the initial analysis in this Article simplifies variation within these industries by focusing on the dominant firms within a given industry, which will also be the authority within an industry that tends to drive its advocacy. In practice, different subgroups within an industry will have different innovation characteristics. This additional texture is incorporated later in the Article to further refine proxy signal analysis.[88] The particular traits analyzed below are based on an extensive literature search to identify pertinent innovation characteristics.[89]

The following discussion demonstrates how industries can be evaluated in order to identify their pertinent innovation characteristics. The analysis is based on existing empirical data from a variety of sources for different industries, as indicated in the footnotes. As noted above, this discussion is not intended to be the final word on innovation characteristics but to demonstrate that such analysis is feasible and that the appropriate information can be derived from relevant sources or through additional work. The goal of the analysis is to eventually select a small collection of suitable subindustries whose preferences come closest to mirroring society's. The analysis of innovation characteristics is summarized at the end of this section in Table 1.

1. Variation in Technology Characteristics

Due to variation in underlying technologies, the manner of innovation varies significantly from industry to industry. Some industries are much more research and development intensive than others. The pharmaceutical and biotechnology sectors, for example, require costly, time-consuming, risky research and development in order to achieve new innovation, such as new drugs and new biologics.[90] Developing a new drug or biologic routinely takes a decade or more, costs hundreds of millions of dollars, and often requires testing hundreds of alternatives or compounds.[91]

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88. *See infra* Part III.F.1.

89. *See supra* note 88; *see also infra* notes 90–121.

90. Burk & Lemley, *supra* note 6, at 1581–82, 1676.

91. *Id.*; Geeta Anand, *The Most Expensive Drugs—Rx for an Industry: As Biotech Drug Prices Surge, U.S. is Hunting for a Solution*, WALL ST. J., Dec. 26, 2005, at A1.

Semiconductor development similarly takes years and costs billions of dollars.[92] Other industries, including software and information technology are less research intensive, allowing for much cheaper innovation that generally takes less time, and is lower risk.[93] New software applications can often be produced for under a million dollars.[94]

Innovation also varies across industry due to technological differences in the ease of reverse engineering and the lifecycle of new technological development. Some technologies, such as medical devices and pharmaceuticals, are relatively easy to reverse engineer, while others, such as certain biotechnology processes, are much harder.[95] Similarly, some technological industries, including semiconductors and software, evolve very quickly, with technological turnover on the order of several years or less.[96] New innovation in these industries quickly becomes obsolete. Other industries, including pharmaceuticals and some mechanical fields, utilize technologies with much longer lifecycles.[97] The technological lifespan of innovation in these industries can measure decades, sometimes exceeding the twenty-year length of a patent term.[98]

2. Variation in Patenting Characteristics

Due in part to differences in technology characteristics, industries also vary significantly in how they interact with, and seek to take advantage of, the patent system.[99] The utility and methodology of patenting, for example, depends significantly on whether the paradigm form of innovation in an industry involves discrete stand-alone innovation, such as

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92. Burk & Lemley, *supra* note 6, at 1582.

93. *Id.* at 1582–83, 1687.

94. *Id.* at 1582. Distinct from an industry's research and development intensity is its research and development productivity; that is, how much innovation is achieved per research and development dollar spent. *See generally* ROBERT M. HUNT & LEONARD J. NAKAMURA, THE DEMOCRATIZATION OF U.S. RESEARCH AND DEVELOPMENT AFTER 1980 (2010).

95. Arman H. Nadershahi & Joseph Reisman, *Generic Biotech Products: Provisions in Patent and Drug Development Law*, BIOPROCESS INT'L, Oct. 2003, p. 26–31.

96. Bronwyn Hall & Rosemarie Ham Ziedonis, *The Patent Paradox Revisited: An Empirical Study of Patenting in the U.S. Semiconductor Industry, 1979–1995*, 32 RAND J. ECON. 101, 102 (2001); Aaron K. Chatterji & Kira Fabrizio, Professional Users as a Source of Innovation: The Role of Physician Innovation in the Medical Device Industry 8 (Mar. 2, 2008) (unpublished manuscript), *available at* http://www.bus.umich.edu/Academics/Departments/Strategy/pdf/W2008%20Chatterji.pdf.

97. Burk & Lemley, *supra* note 6, at 1664.

98. Michael Meehan, *Increasing Certainty and Harnessing Private Information in the U.S. Patent System: A Proposal for Reform*, 2010 STAN. TECH. L. REV. 1, 13 (2010).

99. BURK & LEMLEY, *supra* note 13, at 49–54 (discussing the industry-specific nature of the patent system with respect to patent prosecution and the scope of patented subject matter).

a new drug or device, or whether most innovation involves cumulative advances that evolve dependently from one innovation to the next, as occurs in the semiconductor, software, and information technology industries.[100]

Patenting characteristics vary further depending on the relationship between the form of innovation and what is actually commercialized. Innovation can involve individual, complete products that are commercialized (for example, most pharmaceuticals), components of products that are commercialized (as in the telecommunications and information technology industries), or processes (for example, in much financial innovation).[101] Some industries cannot be cabined in this manner—the biotechnology industry, for instance, produces significant innovation that falls into all three categories.[102]

The relationship between industry innovation and patenting is also significantly affected by the manner in which a firm is able to protect and appropriate returns from innovation. Certain industries, including pharmaceuticals, biotechnology, and medical devices depend heavily on patent protection to allow them to appropriate returns from innovation.[103] These industries have only weak alternatives to patent protection, in part because their products are easy to reverse engineer and copy, precluding trade secret or other forms of protection. Other industries, such as the financial and software fields, rely primarily on methods besides patent protection to leverage their intellectual assets.[104] Such industries are able to take significant advantage of lead-time, secrecy, and complementary manufacturing and marketing techniques to appropriate value from their innovation, in some cases regardless of patent protection.[105]

Partially related to variation in how firms protect and profit from their innovation is variation across industries in incentives to produce innovation in the first instance. While innovation in many industries is

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100. Burk & Lemley, *supra* note 6, at 1590; Julie E. Cohen & Mark A. Lemley, *Patent Scope and Innovation in the Software Industry*, 89 CAL. L. REV. 1, 41 (2001).

101. Burk & Lemley, *supra* note 6, at 1590; Barnett, *supra* note 30, at 428.

102. Wesley M. Cohen et al., *Protecting Their Intellectual Assets: Appropriability Conditions and Why U.S. Manufacturing Firms Patent (Or Not)* 19 (Nat'l Bureau of Econ. Research, Working Paper No. 7552, 2000).

103. *Id.*; Ted M. Sichelman & Stuart J.H. Graham, *Patenting by Entrepreneurs: An Empirical Study*, 17 MICH. TELECOMM. TECH. L. REV. 111, 148–49 (2010).

104. *Id.*; Barnett, *supra* note 30, at 403.

105. Cohen et al., *supra* note 102, at 24; Josh Lerner, *The New New Financial Thing: The Origins of Financial Innovations*, 79 J. FIN. ECON. 223, 228 (2006); Jonathan Barnett, *Private Protection of Patentable Goods*, 25 CARDOZO L. REV. 1251, 1257–69 (2004) (discussing a variety of alternative appropriation mechanisms besides intellectual property rights, including various first-mover strategies, copy protection mechanisms, and private contract).

primarily motivated by the prospect of financial reward, innovation in certain industries springs significantly from other motivations as well. Individuals may be motivated to innovate for a variety of personal, cultural, and social reasons in addition to potential profits.[106] University and government funding and support, for instance through the National Science Foundation or National Institutes of Health, also provide non-intellectual property-based motivation for innovation in the form of research funding and rewards.[107] These sources can form the direct or indirect basis of much innovation, for example in parts of the pharmaceutical and biotechnology sectors.[108]

3. Variation in Market Structure Characteristics

Variation in firm and market structure across different industries also affects industry preferences for patent protection.[109] Four of the most significant dimensions of variation for these purposes concern whether an industry is significantly concentrated or more diffuse; whether an industry is generally made up of large firms, small firms, or individuals; whether an industry is a net consumer or net producer of innovation; and what patterns of intellectual property enforcement are in a given industry.

The pharmaceutical industry tends to be dominated by large firms that own their own patents on internally produced innovation.[110] Intellectual property enforcement in the industry is roughly average.[111] The biotechnology industry is somewhat similar, although there is greater diversity in innovation firm size.[112] Both industries are net producers of innovation; they require relatively limited or self-controlled intellectual property inputs, and their commercialization products are primarily intellectual property based. The medical device industry firm size lies at the other end of the spectrum, being made up mostly of small firms and

106. Diane Leenheer Zimmerman, *Copyrights as Incentives: Did We Just Imagine That?*, 12 THEORETICAL INQUIRIES IN LAW 29, 36–40, 46–47 (2011); BURK & LEMLEY, *supra* note 13, at 44.

107. ZIMMERMAN, *supra* note 106, at 48.

108. *Id.*

109. *See* Herbert J. Hovenkamp, Competition for Innovation 2–9, 26 (Oct. 1, 2012) (unpublished manuscript), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2008953 (noting and discussing how innovation is "highly sensitive to market structure").

110. Alfonso Gambardella, *Competitive advantages from in-house scientific research: The US pharmaceutical industry in the 1980s*, 21 RES. POL'Y 391 (1992).

111. John R. Allison et al., *Valuable Patents*, 92 GEO. L.J. 435, 472 (2004).

112. Burk & Lemley, *supra* note 6, at 1591; David E. Adelman & Kathryn L. DeAngelis, *Patent Metrics: The Mismeasurement of Innovation in the Biotech Patent Debate*, 85 TEX. L. REV. 1677, 1687 (2007).

individuals.[113] Innovations in medical devices are often used by individuals and firms who developed the inventions, but are also licensed to others.[114] The medical device industry has one of the highest rates of patent enforcement litigation.[115]

The semiconductor industry is dominated by a relatively small number of large firms, each of which have substantial patent portfolios that the firms routinely cross-license among each other.[116] Consequently, enforcement of patent rights within the industry is limited.[117] The computer software industry, on the other hand, is an extremely diversified industry made up of firms of all different sizes.[118] Many of the larger firms are net consumers of innovation, relying in significant manner on innovation achieved by others.[119] Enforcement of patent rights in the industry tends to be relatively strong.[120] The telecommunications industry also varies greatly in firm size and the dominant firms similarly rely heavily on licensing patent rights from original equipment manufacturers to produce products for consumers.[121]

The financial industry is heavily diversified in firm size. Most innovation takes place within industry firms, although it appears that smaller firms may generally be more innovative than larger ones.[122] Patent enforcement is low.[123] The mechanical industry may be the largest in terms of numbers of firms, and most diverse in firm size, of any of the patenting industries discussed. Mechanical industries tend to be net producers of innovation, usually requiring relatively limited intellectual property inputs. Patent owning firms are more likely to litigate than average.[124]

Table 1 details the analysis of innovation characteristics by industry.[125]

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113. Burk & Lemley, *supra* note 6, at 1591.

114. Chatterji & Fabrizio, *supra* note 96, at 8.

115. Allison, *supra* note 111, at 472.

116. Burk & Lemley, *supra* note 6, at 1628.

117. Allison, *supra* note 111, at 468.

118. *See* DEPARTMENT OF LABOR, BUREAU OF LABOR STATISTICS, SOFTWARE PUBLISHERS, CAREER GUIDE TO INDUSTRIES, 2010–2011 EDITION, *available at* http://www.bls.gov/oco/cg/cgs051.htm (last visited Oct. 18, 2010).

119. Burk & Lemley, *supra* note 6, at 1592.

120. *Id.*

121. Michael Gallaher & Jeffrey Petrusa, *Innovation in the U.S. Service Sector*, 31 J. TECH. TRANSFER 611, 616 (2006).

122. Lerner, *supra* note 105, at 224.

123. Barnett, *supra* note 30, at 427.

124. Allison, *supra* note 111, at 473.

125. The information in the cells in Table 1 is derived from the sources listed in notes 86–120.

TABLE 1: PATENT INDUSTRY INNOVATION CHARACTERISTICS

INDUSTRY	TECHNOLOGY CHARACTERISTICS		PATENTING CHARACTERISTICS				MARKET CHARACTERISTICS			
	Technological Lifecycle	Research & Development Intensity	Alternative incentives to innovate	Alternatives to IP protection	Product, component, or process	Stand-alone v. cumulative innovation	Patent Enforcement	Net consumer v. producer of innovation	Innovator firm size	Industry Concentration
Biotechnology	long	high	some	few	all	stand alone	moderate	primarily producer	diverse	mildly diffuse
Financial	short	low	many	many	product/ process	cumulative	high	producer	diverse	concentrated
Information Technology	short	low	many	many	component	cumulative	high	mixed	diverse	diffuse
Mechanical	medium	low	some	some	product/ process	stand alone	moderate	mixed	small/ individual	diffuse
Medical Device	short	medium	some	few	product/ process	stand alone	high	mixed	small/ individual	diffuse
Pharmaceutical	long	high	some	few	product/ process	stand alone	moderate	producer	large	concentrated
Semiconductor	short	high	few	many	components	cumulative	low	mixed	large	concentrated
Software	short	low	many	some	component/ process	cumulative	high	consumer	large	diffuse
Telecommunications	short	medium	few	some	components	cumulative	moderate	mixed	diverse	concentrated

C. Industry Characteristics as Proxy Signals for Social Preferences

Industry heterogeneity with respect to the patent system provides a previously untapped source for collecting information concerning socially beneficial levels of patent protection. Many of the traits that cause industries to vary from one another in their patent preferences reveal information not just about the pertinent technology or market, but also about whether the particular industry's incentive versus exclusivity trade-offs can be expected to mirror societal trade-offs. Depending on the particular characteristics of a given industry, it will tend to advocate for excessively weak patent rights from a social perspective, excessively strong patent rights, or, in certain instances, just about the right level of patent protection.

It is possible to work through the technological, patenting, and market characteristics delineated above to identify those characteristics that tend to lead an industry to prefer socially desirable levels of patent protection. This task involves identifying industry traits that are inclined to produce smaller, as opposed to larger, variation between private versus social innovation preferences. This search will ascertain industries that face incentive versus exclusivity trade-offs that mirror society's as closely as possible. For example, as discussed earlier, society aspires to balance the production and consumption interests in innovation in order to optimize incentives. An industry that naturally balances these interests due to its particular innovation characteristics will tend to mirror society's preferences on this characteristic. More broadly, an industry that faces the same trade-offs as society across the range of innovation characteristics will have a private preference function that has a similar shape to the social innovation function. Such an industry will tend, for purely self-interested reasons, to prefer and advocate for socially beneficial levels of patent protection from a societal perspective.

An alternate way to understand this analysis is as an effort to identify which industry characteristics are either likely to produce few externalities with respect to patent protection, or, to the extent there are significant externalities, to identify which characteristics are likely to produce relatively constant externalities across various levels of patent protection. In either case, the identified industry characteristics will produce private preference profiles with a similar form to the social profile. Though each industry is motivated to maximize its private value of innovation, selecting the proper innovation characteristics will mean these private preferences align with social preferences.

Engaging in this analysis produces a powerful result. Even though we may not be able to directly identify the form or maximum of the social patent protection function, we may instead identify a proxy that mirrors this function's form. Because the proxy's maximum will be located near the same level of propertization as the social function's maximum, understanding such a proxy's preferences will provide valuable information concerning how to optimize the relationship between patent law and innovation.

D. Identifying Optimal Innovation Characteristics

The following analysis disaggregates the industry innovation characteristics identified above to analyze the effect of each characteristic on patent preferences individually. That is, it explores the impact of variation in a given innovation characteristic on the correspondence between private and social innovation trade-offs, assuming all other characteristics are kept constant.

Production vs. Consumption of Innovation. One of the most significant factors affecting industry positions on patent protection is whether an industry is a net consumer or net producer of innovation. The pharmaceutical industry, for example, is largely a net producer of innovation products, developing new chemical drugs that require relatively few patent protected inputs.[126] Industries that are net producers of innovation will feel limited exclusivity costs of patent protection but recognize great incentive benefits from patent rights, and thus will tend to favor strong propertization. As propertization increases for these industries, the marginal private benefit of increased incentives will regularly outweigh the marginal private cost of greater exclusivity.

The software industry presents the opposite situation as a net consumer of innovation. Large software firms, such as Microsoft, are heavy consumers of innovation, requiring many inputs from independent smaller entities and individuals in order to develop their products.[127] Even though the software industry produces some innovation as a whole, the dominant firms in the industry, and thus the ones that will drive industry advocacy, tend to be net consumers. Net consumers of innovation face large exclusivity costs, but derive relatively limited incentives from increased

126. FEDERAL TRADE COMMISSION, TO PROMOTE INNOVATION: THE PROPER BALANCE OF COMPETITION AND PATENT LAW AND POLICY 10 (Oct. 2003), *available at* http://ftc.gov/os/2003/10/innovationrpt.pdf.

127. Kesan & Gallo, *supra* note 54, at 1351–53.

patent protection. They will tend to favor relatively weaker patent propertization, preferring to leverage the substantial positive externalities that can be reaped by taking advantage of innovation spillovers without paying the innovation's full development costs.[128]

Some industries are more mixed. The semiconductor field, as an example, is made up of firms that both rely on others' technology and produce their own innovation. A new semiconductor chip introduces innovation, but also depends on technology covered by thousands of other patents, thus significantly consuming innovation as well.[129] Similarly, telecommunications companies profit from innovation, but also depend heavily on innovation by original equipment manufacturers to incorporate into their products. Industries that are balanced in their consumption and production of innovation are forced to consider both the beneficial incentives and exclusivity costs of patent rights, and therefore tend to face more similar innovation trade-offs to society as a whole.[130]

Stand-alone vs. Cumulative Innovation. Another significant factor affecting patent preferences concerns whether technological advance in an industry generally involves stand-alone or cumulative innovation. Information technology innovation, for example, is highly cumulative, each new innovation building upon and incorporating many previous advances. Pharmaceuticals, on the other hand, are often stand-alone patented products. Industries that involve stand-alone innovation are expected to prefer stronger levels of patent protection because they will tend to require relatively limited intellectual property inputs and consequently face few exclusivity costs. Industries with cumulative innovation, on the other hand, must necessarily take into account the cost of input innovation, and consequently will tend to balance the incentive value of propertization against its exclusivity cost. Industries with

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128. Net consumer industries generally will not desire zero protection because their preference for limited propertization will be moderated by a desire for enough incentives for innovation producers to continue to innovate. A net-consumer with a long-term perspective could recognize the same trade-offs as society, but would face the same information limitation problems as public entities in trying to identify the appropriate level of propertization. In addition, a variety of behavioral and functional limitations generally preclude firms and industries from taking long-term perspectives in the market. Nadelle Grossman, *Turning a Short-Term Fling into a Long-Term Commitment: Board Duties in A New Era*, 43 U. MICH. J.L. REFORM 905 (2010) (discussing how corporate boards and firm executives often face biases towards short-term goals).

129. ROBERT M. HUNT, THE VALUE OF R&D IN THE SEMICONDUCTOR INDUSTRY ch. 3 (1996); Mark A. Lemley, *Ten Things to do About Patent Holdup of Standards (And One Not To)*, 48 B.C. L. REV. 149, 151 (2007).

130. *See* Barnett, *supra* note 30, at 390 (discussing how firms that both produce and use intellectual property goods will tend to prefer an intermediate level of intellectual property protection).

cumulative innovation face fewer innovation externalities, and therefore will more closely reflect the innovation trade-offs that society faces.

Product, Component, and Process Protection. For comparable reasons, similar effects should be seen for industries that use patents to protect commercializable products (who often can ignore much of the exclusivity cost of patent protection) versus those who protect components (who are forced to take exclusivity costs into account to a greater extent). The former are anticipated to prefer stronger patent protection; the latter will desire weaker rights. Most medical device and pharmaceutical patents protect products, while information technology and telecommunications patents often cover components. Industries that primarily patent processes present a mixed bag. To the extent companies can execute a process in secret in order to commercialize a product, such companies may favor excessive patent propertization, as they face few exclusivity costs from intellectual property protection.[131] On the other hand, precisely because process innovation industries may be able to secure profits while maintaining innovative processes in secret may mean that such industries are not very concerned with the level of protection one way or the other.[132] This situation thus raises issues of appropriability.

Alternative Means of Appropriability. How an industry appropriates value from innovation will have significant effects on the relationship between private and social trade-offs. Industries that are able to rely predominantly on alternate appropriability mechanisms, besides patent rights, to profit from their innovation receive few benefit incentives from patent protection. Consequently, such industries may not face socially equivalent trade-offs. This is not to claim that such industries definitively do not face socially equivalent trade-offs, only that we cannot tell. It is possible that an industry presented with few benefits from patent protection also happens to face correspondingly limited exclusivity costs, producing a socially equivalent trade-off balance on net.[133] Rather than needing to definitively analyze this complex issue, proxy signal analysis

131. To the extent a process to produce a commercialized product can be conducted in secret, there is both a lower likelihood that anyone would bother to acquire a patent on the process, and a greater likelihood that competing firms could secretly infringe the process. *See* Sichelman & Graham, *supra* note 103, at 161–62 (finding that secrecy is viewed as a more adequate form of protection for process versus product innovation based on a survey of American entrepreneurial companies).

132. Michael A. Carrier, *Two Puzzles Resolved: Of the Schumpter-Arrow Stalemate and Pharmaceutical Innovation Markets*, 93 IOWA L. REV. 393, 405 (2008) (noting secrecy is often more effective for protecting process inventions).

133. This relationship likely could be investigated by comparing patenting and litigation propensity across different industries, though the use of defensive and strategic patenting would make it hard to derive concrete results.

instead can focus on identifying industries where we have the greatest reason to believe that they do face socially equivalent trade-offs. It is not necessary to reach a conclusion about where other industries lie in order to select those that appear to mirror society.

Alternative Incentives to Innovate. The extent of alternative incentives to innovate, beyond patent rights, will affect industry preferences in a somewhat similar fashion. Industries with substantial alternative incentives recognize few benefits from patent protection, potentially upsetting their balance between incentives and exclusivity. Again, these industries may happen to also have limited exclusivity costs, but we do not know whether this balances out. Instead, we can select industries with characteristics that more clearly indicate societal correspondence.

Technology Characteristics. Technological research and development characteristics have substantial effects on intellectual property preferences. Industries with rapid technology lifecycles, and with cheap and short innovation characteristics, will tend to have comparatively fewer innovation incentives available from the patent system. Any industry with a technology lifecycle of three years of less, for example, will have only limited opportunity to benefit from patent protection, as the average patent pendency is now about three years long.[134] The software and information technology industries both appear to fall into this category.[135] Where innovation lifecycles are long and routinely outlast patent terms, on the other hand, innovation may produce significant externalities, and industries in these fields therefore may not possess private preferences that regularly mirror social innovation trade-offs either. Biotechnology and pharmaceuticals appear to fall into this camp.[136]

Market Concentration. Market structure within an industry can have a significant effect on patent propertization preferences. Highly diverse industries, with many firms of various sizes, may tend to prefer non-optimal levels of patent protection. This will occur because as firm

134. Warren K. Mabey, Jr., *Deconstructing the Patent Application Backlog . . . A Story of Prolonged Pendency, PCT Pandemonium & Patent Pending Pirates*, 92 J. PAT. & TRADEMARK OFF. SOC'Y 208 (2010). Certain industries, such as pharmaceuticals and biotechnology, take much longer. *Id.* Industries with technology lifecycles under three years can still receive some benefit through patenting, such as by acquiring defensive rights, negotiation power, or as a signal to secure investment and financing. *Id.*

135. Chris J. Katopis, *Perfect Happiness?: Game Theory as a Tool for Enhancing Patent Quality*, 10 YALE J.L. & TECH. 360 (2008).

136. Similar to the discussion above, it is possible in that industries with particularly short or lengthy technology lifecycles also face fewer exclusivity costs or negative externalities, respectively, such that their net preferences could reflect society's desired trade-offs, but this is difficult to know and not necessary to resolve for the analysis.

numerousity and diversity increase, the transaction costs of patent rights will increase, introducing significant externalities with respect to innovation in the industry.[137] A study of the semiconductor industry, for example, found that semiconductor firms patent more aggressively, but do not engage in any greater research and development, when rights are more highly fragmented.[138]

An industry in which one or a couple firms can use patent protection to acquire a monopoly, on the other hand, may permit such firms to impose substantial exclusivity costs on others, such that they may not reflect socially desired preferences either.[139] Industries with some concentration, but not so much as to tend towards monopolistic pricing power, may be more likely to reflect socially desired incentive versus exclusivity trade-offs.[140] This is not to state that industries with moderate concentration will always provide the greatest innovation environment (a difficult question famously pitting Joseph Schumpeter's arguments for concentration against Kenneth Arrow's arguments for competition),[141] only that such industries are more likely to produce the socially equivalent trade-offs that are useful from a proxy signaling perspective.

Innovator Firm Size. Some research indicates that patents might be more important to small firms and individual innovators, who cannot easily take advantage of alternative appropriability mechanisms provided by reputational goodwill, tacit knowledge, production efficiencies, and other factors, or for whom patents may be more necessary to secure investment funding.[142] Industries with heavy representation from small

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137. Barnett, *supra* note 30, at 411–13, 423 (noting that where coordination among firms is expensive, transaction costs are greater and tend to inhibit socially optimal propertization outcomes).

138. Ziedonis, *supra* note 51, at 817.

139. *See, e.g.*, Kenneth J. Arrow, *Economic Welfare and the Allocation of Resources for Invention*, *in* THE RATE AND DIRECTION OF INVENTIVE ACTIVITY 609, 619–22 (Nat'l Bureau of Econ. Research 1962) (discussing problematic effects of monopolies on the dissemination of innovation). An industry which presents a natural monopoly may not significantly care about intellectual property rights, as it can secure supracompetitive profits regardless of intellectual property law.

140. *See* HOVENKAMP, *supra* note 109, at 6–7 (explaining that current understanding is that innovation is often highest in moderately concentrated markets, and lower in more highly monopolized or concentrated markets); Philippe Aghion et al., *Competition and Innovation: An Inverted U Relationship*, 120 Q.J. ECON. 701 (2005) (same); Arrow, *supra* note 139 (discussing how concentrated industries will face fewer transaction costs from propertization and will tend to progress towards socially optimal propertization outcomes). Other authors have produced evidence that oligopolistic markets, rather than either monopoly or perfect competition, may produce the greatest incentives for innovation. BAUMOL, *supra* note 50, at 30–42; SWANN, *supra* note 50, at 218–20.

141. *See* Carrier, *supra* note 132, at 403–04 (discussing the Schumpeter-Arrow debate over the relationship between industry concentration versus competition and innovation).

142. Stuart J.H. Graham et al., *High Technology Entrepreneurs and the Patent System: Results of the 2008 Berkeley Patent Survey*, 24 BERKELEY TECH. L.J. 1255 (2009); Barnett, *supra* note 105, at

firms and individuals are therefore likely to recognize most of the incentive benefits, as well as the exclusivity costs, of patent protection. Industries dominated by large firms on the other hand, due to their ability to rely on various private appropriability mechanisms to establish barriers to entry and profit from their intellectual assets, may not face the full incentive benefits of patent propertization, and therefore are less likely to face socially optimal trade-offs.[143]

Patent Enforcement. Finally, patterns of patent enforcement within an industry will affect intellectual property preferences. Industries with high levels of enforcement will tend to face significant transaction costs and externalities due to patent rights. Externalities arise because a firm considering whether to bring an infringement lawsuit does not factor the defendant's or society's litigation costs into their litigation decision analysis. High enforcement cost industries may therefore face excessive exclusivity costs when compared to society's propertization trade-offs. At the other end of the spectrum, industries where there is no realistic threat of patent enforcement also will not mirror society's trade-offs because they are effectively exempt from the exclusivity costs of patenting. The most promising industries, in terms of their penchant for paralleling social trade-offs, will be industries where there is a real threat of intellectual property enforcement if others' rights are breached (producing rights compliance, and the ability to profit thereby), but such enforcement is rarely actually applied (minimizing the transaction costs of enforcement). This circumstance would arise in industries with a high degree of industry conformity in respecting the intellectual property rights of others.[144] Firms in such industries will have the opportunity to benefit from their own innovation, but also face the access costs of having to respect intellectual property rights of others, producing the equivalent social trade-offs that proxy signal analysis seeks.

1254–55, 1283; Long, *supra* note 25, at 642–43; Ronald J. Mann, *Do Patents Facilitate Financing in the Software Industry?*, 83 TEX. L. REV. 961 (2005); *see also* HOVENKAMP, *supra* note 109, at 7 (explaining why small firms may be more likely to produce more radical innovation).

143. HOVENKAMP, *supra* note 109, at 7; Barnett, *supra* note 105, at 1254–55.

144. *See* Robert C. Ellickson, *Of Coase and Cattle: Dispute Resolution Among Neighbors in Shasta County*, 38 STAN. L. REV. 623 (1986) (providing a field study of how social norms can supersede formal legal entitlements in dispute resolution processes in the real property context).

E. Innovation Industries with Optimal Signals

The relationship between industry characteristics and the likelihood that such characteristics will cause an industry to face the same incentive versus exclusivity trade-offs as society can now be mapped. Table 2 codes the industry characteristic data of Table 1 based on whether a given characteristic is anticipated to tend to cause private industry preferences to parallel social preferences. Where a characteristic is expected to produce trade-offs that excessively favor the incentive benefits of patenting, producing propertization preferences that are stronger than socially optimal, a "+" sign is used; where a characteristic is expected to create trade-offs biased towards excessive exclusivity costs, producing propertization preferences that are weaker than socially optimal, a "-" sign is used. Where an industry characteristic is expected to tend to produce socially equivalent trade-offs, keeping all other characteristics constant, that record is coded with an "=" sign.

These results provide a first order analysis of where industries stand in relation to socially optimal trade-offs and patent law. Even in this introductory form, the analysis reveals valuable and previously unrecognized information concerning the interaction between patent law and innovation.

Several results jump out from Table 2. First, the results explain why the pharmaceutical and biotechnology industries on the one hand, and the software, financial, and information technology industries on the other, have been at loggerheads over patent reform.[145] The pharmaceutical industry results are dominated by characteristics that tend towards a desire for overly strong propertization, with few elements that indicate socially equivalent or weak propertization incentives. The biotechnology industry possesses more characteristics than pharmaceuticals that direct towards equivalent trade-offs, but the results are still dominated by strong propertization characteristics. Not surprisingly, the pharmaceutical and biotechnology industries have aligned to push for stronger patent rights on every major patent reform bill and every major patent case before the Supreme Court in recent history.[146]

145. BURK & LEMLEY, *supra* note 13, at 4, 100–02.
146. *Id.* at 100–02; INNOVATION ALLIANCE, LETTER: INDUSTRIES FROM U.S. STATES EXPRESS CONCERN OVER PATENT LEGISLATION, *available at* http://innovationalliance.net/news-and-resources/letter-industries-us-states-express-concern-over-patent-legislation.

TABLE 2: PATENT INDUSTRY INNOVATION SIGNALS

INDUSTRY	TECHNOLOGY CHARACTERISTICS		PATENTING CHARACTERISTICS				MARKET CHARACTERISTICS			
	Technological Lifecycle	Research & Development Intensity	Alternative incentives to innovate	Alternatives to IP protection	Product, component, or process	Stand-alone v. cumulative innovation	Patent enforcement	Net consumer v. producer of innovation	Innovator firm size	Industry concentration
Biotechnology	+	+	=	+	=	+	=	+	=	–
Financial	–	–	–	–	=	=	–	+	=	=
Information Technology	–	–	–	–	=	=	–	=	=	–
Mechanical	=	–	=	=	+	+	=	=	=	–
Medical Device	–	=	=	+	+	+	–	=	=	–
Pharmaceutical	+	+	=	+	+	+	=	+	–	=
Semiconductor	–	+	+	–	=	=	=	=	–	=
Software	–	–	–	=	=	=	–	–	–	–
Telecommunications	–	=	+	=	=	=	=	=	=	=

The information technology, financial services, and software industries, conversely, are each dominated by industry characteristics that tend to produce a desire for overly weak propertization. Each of these industry profiles does display several characteristics that tend towards socially equivalent trade-offs, but each industry has no or only one characteristic that indicates strong rights, likely leading to a bias for propertization that is weaker than is socially warranted. Not surprisingly, these three industries have aligned to uniformly argue for weaker patent rights on every recent patent reform bill and Supreme Court patent case.[147] Although the results for the five industries discussed so far should not be surprising to those who follow patent debates, they lend credence to the proxy signal methodology by indicating that the relevant industry characteristics can be both identified and accurately evaluated.[148]

The characteristics of the mechanical industry are highly fractured, presenting some elements that indicate a preference for weak rights, some a preference for strong rights, and some a preference for more optimal patenting trade-offs. These results are likely a consequence of both the actual innovation characteristics in the industry and the fact that mechanical innovation varies widely across many types of firms and innovation, rendering the industry particularly hard to uniformly characterize. Simply because an industry has a preference for weak rights under one characteristic and strong rights under another does not mean that these preferences cancel out. Not only may one preference be stronger than another (the tendency towards greater exclusivity on one characteristic may outweigh the tendency towards greater incentives on another), but a given type of preference may moderate the effects of others because the characteristics can interact. An industry with strong alternative appropriability means, for example, may not need to rely on patents at all, and therefore this characteristic can swamp the fact that the industry also produces stand-alone product innovation, which would otherwise indicate a tendency for strong rights. Analyzing the industry characteristic data requires taking into account these contextual relationships. Because it is unclear how these preferences balance out for the mechanical industry, this industry is not a good candidate to provide proxy signals.

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147. BURK & LEMLEY, *supra* note 13, at 100–02.

148. Lending further credence, other studies have found that the "patent premium," i.e. the incremental value of an invention that is realized by patenting it, tends to be greatest for biotechnology, pharmaceutical, and medical device companies. Ashish Arora et al., *R&D and the Patent Premium*, 26 INT'L J. INDUS.ORG. 1153 (2008).

The remaining three industries, semiconductors, medical devices, and telecommunications, each appear to offer more socially comparable trade-offs, and therefore may offer useful proxy signals for patent law. Each of these three industries has more innovation characteristics that indicate socially equivalent trade-offs than characteristics that produce either an exclusivity or incentives bias. Further, for each of these industries, the characteristics that do not indicate equivalent trade-offs are somewhat split between biases towards excessive incentives and excessive exclusivity. Though these biases cannot simply be assumed to balance out, the existence of a mix produces a possibility for this prospect.

To explore the possible beneficial signaling propensities of these industries, it is necessary to analyze those characteristics which do not indicate a close correspondence between private and social trade-offs to determine whether they indicate a clear net bias one way or the other. The semiconductor industry stands out from the other two in providing strong appropriability alternatives to patent protection. As noted above, this characteristic can swamp others, and appears to do so here with respect to industry characteristics that would otherwise indicate a preference for stronger than optimal patent rights. Consistent with this analysis, the semiconductor industry has generally advocated for weaker patent rights in both legislation and before the Supreme Court in recent patent law disputes.[149]

The medical device and telecommunications industries do not present clearly biasing characteristics, and, though not perfect indicators, appear to represent the closest parallel trade-offs to society under the analysis thus far. Each industry possesses a wealth of characteristics that indicate trade-offs which mirror society's, and each displays a roughly even split among its remaining characteristics, without any factors that are clearly strongly biasing one way or the other. Notably, the advocacy positions of these two industries have been more mixed over time than any of the other innovation industries discussed. Medical device industry advocacy has varied, sometimes advocating for stronger, sometimes for weaker, patent rights, in reference to Supreme Court patent cases and patent reform efforts of the past five years.[150] The telecommunication industry's

149. *E.g.*, Brief for Intel Corp., et al. as Amici Curiae Supporting Petitioner at 5, *KSR Int'l v. Teleflex, Inc.*, 550 U.S. 398 (2007) (No. 04-1350); Brief for the Business Software Alliance as Amicus Curiae Supporting Petitioner at 4, *eBay v. MercExchange*, 547 U.S. 388 (2006) (No. 05-130).

150. *Compare* Brief for Avery Dennison Corporation et al. as Amici Curiae Supporting Petitioner, *Re Seagate Tech. LLC*, 497 F.3d 1360 (2007) (No. 06-M830) (brief supporting the petitioner in their advocacy for weaker patent rights joined by a medical devices company), *with* Brief for General Electric et al. as Amici Curiae Supporting Respondents, *KSR Int'l v. Teleflex, Inc.*, 550 U.S. 398

advocacy presents a slightly different pattern. After a period of consistently advocating for weaker patent protection in patent reform and Supreme Court cases through the earlier part of the 2000s, the industry's pattern of advocacy became more mixed starting in 2006.[151] This chronology is consistent with an industry that perceived a regime of excessive patent protection prior to 2007 rationally shifting its advocacy in response to Supreme Court patent decisions that tended to weaken the strength of patent rights around this time,[152] so as to produce a level of patent rights that now more closely aligns with the industry's desired level of propertization. That the data on advocacy appears to fit the proxy signal methodology predictions lends credence to both the proxy signal framework and the viability of engaging in such analysis.

Based on this preliminary examination, proxy signal analysis indicates that the telecommunications and medical device industries' positions on patent reform should be considered seriously, perhaps more seriously than other industries, as a potential gauge for a socially preferable level of patent protection. These initial results can be applied to current patent law debates to provide a flavor of how proxy analysis can work.

Congress enacted the America Invents Act[153] in the fall of 2011 after six years of hotly contested legislative patent reform efforts. Among other details, the Act shifts the United States to a first-inventor-to-file (as opposed to first-to-invent) patent system and provides new means to contest patent validity.[154] Although watered down from previous patent reform efforts, the America Invents Act still represents the most significant statutory changes to patent law in over fifty years. Proxy signal analysis can be used to indicate whether the America Invents Act will likely promote net incentives to innovate across innovation industries by examining the medical device and telecommunications industries'

(2007) (No. 04-1350) (brief supporting the respondent in their advocacy for stronger patent rights joined by a medical devices company).

151. *Compare* Brief for EchoStar Communications Corporation, et al. as Amici Curiae Supporting Petitioner, In Re Seagate Tech., LLC, 497 F.3d 1360 (2007) (No. 06-M830) (telecommunications companies supporting petitioner in advocating for weaker patent rights), *and* Brief for Computer & Communications Industry Association as Amicus Curiae Supporting Respondent, In re Bilski, 129 S. Ct. 2735 (2009) (No. 08-964) (same), *with* Brief for Teles AG as Amicus Curiae in Support of Neither Party, In re Bilski, 129 S. Ct. 2735 (2009) (No. 08-964) (brief of telecommunications company advocating for a "robust patent system" that rewards technological innovation with strong patent protection).

152. *See, e.g.*, eBay Inc. v. MercExchange, L.L.C., 547 U.S. 388 (2006) (reducing the circumstances in which injunctions are appropriate for patent infringement); KSR Int'l Co. v. Teleflex, Inc., 550 U.S. 398 (2007) (making it harder to satisfy the nonobviousness standard to get a patent).

153. H.R. 1249, 112th Cong. (2011).

154. *Id.*

positions on the Act. Both the leading medical device trade organization and a number of prominent telecommunications companies supported passage of the final version of Act,[155] and it does not appear that any major telecommunications or medical device firms or trade organizations opposed it. Proxy signal analysis thus indicates that the America Invents Act will likely be beneficial to net incentives to innovate for society.

Proxy signals indicate that the Supreme Court may have gotten its decision wrong in one of the most important patent cases of 2011. In *Microsoft v. i4i Limited Partnership*, the Court rejected a challenge to Federal Circuit precedent holding that the presumption of validity afforded an issued patent can only be overcome by clear and convincing evidence.[156] Microsoft sought to lower this standard to a preponderance of the evidence, weakening patent protection in certain circumstances.[157] A number of large telecommunications companies supported Microsoft's position,[158] and none appeared to oppose it, indicating that lowering the standard for invalidating an issued patent would have increased industry incentives to innovate on the whole.

The most significant patent case of the Supreme Court's 2011–2012 term was *Mayo Collaborative Services v. Prometheus Laboratories*, concerning patent claims that covered observing correlations between certain blood test results and patient health so that a doctor would know the proper drug dosage to give a patient.[159] The Court held that the claims were ineligible subject matter, a result that may have significant implications for the breadth of what types of innovation are patentable, particularly concerning innovation in medical diagnoses.[160] Proxy analysis provides a limited signal indicating that the Supreme Court's decision in *Mayo v. Prometheus* will promote net incentives to innovate overall, based on the lone amicus brief filed by a telecommunications company in the

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155. OFFICE OF THE MAJORITY WHIP, COMMITTEE ON THE JUDICIARY, LIST OF SUPPORTERS OF H.R. 1249 (2011), *available at* http://judiciary.house.gov/issues/Patent%20Reform%20PDFS/HR%201249%20Support.pdf.

156. Microsoft v. i4i Ltd. P'ship, 131 S. Ct. 2238 (2011).

157. *Id.* at 2244–45.

158. *See* Brief of Google Inc., et al. as Amici Curiae in Support of Petitioner, *Microsoft*, 131 S. Ct. 2238 (including Verizon Communications Inc., L-3 Communications Corp., Consumer Electronics Association, and Comcast Corp. as amici curiae); Brief of Amici Curiae Computer and Communications Industry Association in Support of Petitioner, *Microsoft*, 131 S. Ct. 2238. No medical device industry associations or firms appear to have supported either side in Microsoft v. i4i.

159. Mayo Collaborative Servs. v. Prometheus Labs., Inc., 132 S. Ct. 1289 (2012).

160. Following the Supreme Court's decision in *Mayo v. Prometheus*, the Court remanded another high-profile patent case, *Association for Molecular Biology v. Myriad*, to the Federal Circuit for reconsideration of the validity of Myriad's patents on genes linked to breast and ovarian cancer. 132 S. Ct. 1794 (2012).

case.[161] Although a number of entities in the medical field filed amicus briefs, most were pharmaceutical or biotechnology companies, not medical device companies, and therefore do not provide additional useful signaling.

This examination reveals how proxy signals can be used to leverage previously untapped but highly valuable information from private industry concerning the appropriate propertization trade-off between incentives and exclusivity. In essence, this method permits us to parse a notoriously difficult challenge: separating, to some extent, the portion of an industry's preferences that arise from a desire for rent-seeking (via wealth transfer from others) from preferences that arise from a desire for a patent system that will actually incentivize greater innovation and increase social welfare. As discussed below, the proxy signal technique can be enhanced in several regards to provide more accurate and more precise signals.

F. Refining Proxy Signal Analysis

Building on the proxy signal framework described above, the following sections flesh out a number of details and respond to likely questions about this new approach. These sections detail how proxy analysis can function dynamically to respond to technology and industry evolution, how to take into account variation in innovation characteristics within industries, the potential to differentiate patent law across different industries, proxy signal measurement and selection challenges, extraterritorial effects, and other factors.

1. Dynamic Proxy Signals

The initial explication of proxy signals above treats the pertinent industry innovation characteristics as static. Though innovation characteristics will tend to be relatively stable in the short-term, they are not static. As technology and industries evolve, their innovation, patenting, and market characteristics will evolve as well. Technological evolution, for example, may significantly lower research and development costs, lead to greater or lesser industry concentration, or affect the difficulty of reverse engineering.[162] All of these changes can lead particular industry

161. *See* Brief of Verizon Communications Inc. and Hewlett-Packard Co. as Amici Curiae in Support of Petitioners, *Mayo Collaborative Servs.*, 132 S. Ct. 1289.

162. Consider, as examples, the development of various mass-production techniques in certain areas of biotechnology that substantially reduced development costs or the effect of the rise of the Internet on the cost of copying and disseminating copyright infringing works. *See* Burk & Lemley,

characteristics to change over time, altering industry patent preferences and leading industries to become more or less socially beneficial in their patent advocacy. Semiconductor technology, for example, evolved from an easy to reverse engineer technology in the 1970s to a technology that was nearly impossible to copy by the late 1980s, significantly changing the availability of alternative appropriability mechanisms.[163] As the result of this technological change, the innovation characteristics of the semiconductor industry changed, and, as would be predicted by proxy analysis, semiconductor industry advocacy evolved as well.[164] Properly taking industry signals into account requires continued attention and response to changing industry characteristics.[165] Proxy analysis is not static, but can operate dynamically to take into account revised industry characteristics as industries evolve.

Industry structure in innovation industries can also be affected by the particular patent regime in place.[166] This would be a problem for proxy analysis if existing industry structure were used as an independent signal of optimal rights, but this is not the case. The identification of optimal proxy industry characteristics is not based on existing industry structure but on which types of characteristics will produce the desired trade-off between incentives and exclusivity. Once optimal types of characteristics are identified, it is then possible to select industries that currently have the desired characteristics. Industries whose structure is strongly dependent on the patent regime are likely precisely those industries whose structure is most likely to change in response to changes in patent law, and thus merit particular attention when considering dynamic effects.

A related concern may be that, once particular industries are selected as offering the best proxy signals available, these industries may lock-in to certain legal rules and methods of innovation that are actually detrimental for innovation overall. If an industry were to do this, however, its innovation characteristics would migrate away from the socially preferred

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supra note 6, at 1583 (discussing mass-production techniques in biotechnology); Ned Snow, *Copytraps*, 84 IND. L.J. 285, 300 (2009) (discussing the ease of copying copyrighted information on the Internet).

163. Ziedonis, *supra* note 51, at 808; HUNT, *supra* note 129, at ch. 4.

164. Pamela Samuelson & Suzanne Scotchmer, *The Law and Economics of Reverse Engineering*, 111 YALE L.J. 1575, 1604 (2002).

165. Properly responding to industry signals would also require various mechanisms to provide for relatively efficient adaptation of law, either through judicial or legislative means, in response to changing industry signals. The practicalities of such political implementation are beyond the scope of this Article.

166. WU, *supra* note 38, at 123 (the most important economic effects of intellectual property may not be on price, but on industry structure).

characteristics. Because proxy signaling will operate dynamically, an industry that locks into socially unfavorable innovation practices will no longer present the desired characteristics and will cease to be one of the industries whose preferences are considered.

2. Subindustry Diversity

The analysis to this point has focused on the dominant firms within a given industry, both for purposes of characterizing the industry and as the primary coordinators of industry advocacy. The industries discussed here, however, are not homogenous. Various subindustries exist within each of the industries analyzed and these subindustries have characteristics and preferences that vary from other subindustries within the same industry.

The biotechnology industry, for example, includes large biopharmaceutical firms that develop and commercialize biologics, small biotech start-ups, agricultural biotechnology companies, and a growing number of follow-on biologic manufacturers.[167] The software industry contains consumer giants, software development companies who are the large firms' clients, and many smaller direct consumer firms.[168] The semiconductor industry contains both fabrication and design firms.[169] Each of these subindustries can have different innovation characteristics. In a related vein, there may be certain identifiable cross-industry subgroups. For example, start-up companies or individual inventors across a variety of industries may share certain innovation characteristics.[170]

By disaggregating the broad industry categorizations to identify pertinent subindustry innovation characteristics, and analyzing the subindustry advocacy positions, the proxy methodology can be refined to produce more precise signals. Increasing the numerousity of entities evaluated increases the likelihood of identifying some that display socially desirable trade-offs across more characteristics. This process can strategically focus on those industries that already display many

167. BIOTECHNOLOGY INDUSTRY ORGANIZATION, *About Bio*, http://bio.org/aboutbio/ (last visited July 15, 2012).

168. *See* KARL M. POPP & RALF MEYER, PROFIT FROM SOFTWARE ECOSYSTEMS: BUSINESS MODELS, ECOSYSTEMS AND PARTNERSHIPS IN THE SOFTWARE INDUSTRY (2010).

169. Hall & Ziedonis, *supra* note 96, at 107.

170. Some research indicates that large firms tend to focus their research and development activities on smaller and process-oriented innovations, while small firms tend to focus on more significant innovative advances concerning products, a difference that may be worth investigating with proxy analysis. P. A. GEROSKI, MARKET DYNAMICS AND ENTRY 220–22 (1991); Barnett, *supra* note 30, at 1289 (collecting multiple studies); *see* Hunt & Nakamura, *supra* note 94, at 14 (reporting that younger, smaller firms are producing a rising share of industry research and development).

appropriate trade-offs. Certain sub-categories of the telecommunication, medical device, and semiconductor industries, for example, may display even more trade-offs that mirror society's than the industries as a whole. In this manner, a small collection of subindustries can be identified that are expected to display relatively socially equivalent trade-offs. Examining the preferences of this collection will both provide more precise proxy signals and serve as a check on any single group having been misanalyzed.

This specification also helps explain recent factionization in the software industry. The software industry has historically been one of the strongest advocates for weakening patent protection, arguing for years in favor of patent reform and filing numerous amicus briefs, uniformly championing weaker rights.[171] In the recent Supreme Court *Bilski v. Kappos* litigation, however, the industry split, with many large software companies still supporting weaker patent rights,[172] but a number of smaller software firms filing amicus briefs in favor of broader, stronger rights.[173] While both large and small software companies share many innovation characteristics, they diverge in two significant respects: alternative appropriability mechanisms and being a net consumer versus net producer of innovation. As discussed above, large software firms tend to be net consumers of innovation, but smaller firms are often net producers—producing the very software that the large firms commercialize. Similarly, large firms have greater means of appropriability outside of patent protection, including their brand name recognition and ability to bundle their innovation with other products and services.[174] Consequently, small software firms are expected to have preferences for stronger patent protection than large firms. What started as a software industry unified in preference for weaker patent protection than the status quo has

171. *E.g.*, Brief for American Innovators Alliance as Amicus Curiae Supporting Petitioner at 8, eBay v. MercExchange, 547 U.S. 388 (2006) (No. 05-130) (brief joined by software companies advocating for weaker patent protection); Brief for the Business Software Alliance as Amicus Curiae Supporting Petitioner, KSR Int'l v. Teleflex, Inc., 550 U.S. 398 (2007) (No. 04-1350) (brief of software company industry organization advocating for weaker patent protections); Brief for Adobe Systems Incorporated et al. as Amici Curiae Supporting Neither Party, In Re Seagate Tech., LLC, 497 F.3d 1360 (2007) (No. 06-M830) (brief of software company advocating for weaker patent protection).

172. *E.g.*, Brief for Microsoft et al. as Amici Curiae Supporting Respondent, *In re* Bilski 129 S. Ct. 2735 (2009) (No. 08-964) (brief of large software company supporting weaker patent protection).

173. *E.g.*, Brief for Borland Software Corporation in Support of Petitioners, *In re* Bilski, 129 S. Ct. 2735 (2009) (No. 08-964) (brief of small software company supporting stronger patent protection); Brief for Armanta et al. as Amici Curiae Supporting Petitioner, *In re* Bilski, 129 S. Ct. 2735 (2009) (No. 08-964) (brief of small software company supporting stronger patent protection).

174. Roberto Mazzoleni & Richard R. Nelson, *The Benefits and Costs of Strong Patent Protection: A Contribution to the Current Debate*, 27 RES. POL'Y 273, 274 (1998); Joseph M. Barnett, *Is Intellectual Property Trivial*, 157 U. PA. L. REV. 1691, 1729 (2009).

factionalized as Supreme Court decisions have weakened the level of patent protection, leaving current patent law at a point somewhere between large software and small software firms' preferences.

A particular challenge in selecting subindustries concerns ensuring that proxy signals maintain appropriate incentives for new firms to enter the innovation market. Proxy signals, by definition, will come from existing entities, and it is possible that patent law based on such signals may not provide the optimal environment for new entrants to enter the market because incumbents will desire a system of propertization that produces high barriers to entry. This concern can be substantially ameliorated by focusing on subindustries with socially equivalent characteristics that contain new entrant representatives and representatives that do not occupy positions of market strength in the given industry.

3. *Effects of Uniform Patent Law*

As noted above, patent law generally presents a one-size-fits-all legal regime.[175] The optimal level of propertization, however, varies by industry due to variation in innovation characteristics.[176] Not only does the pharmaceutical industry privately prefer stronger patent protection than the information technology industry, but it is also quite possible that the socially optimal level of propertization is higher for pharmaceuticals (though not necessarily as high as the industry itself desires). The variation in optimal patent law across industry raises two issues for proxy signal analysis: first, whether proxy analysis needs to be weighted by industry size, and second, whether the proxy approach can be applied to industry-specific patent law.

To evaluate the weighting issue, consider a world with only three industries, represented by the preference functions already presented in Figure 3. In this world, even though Industry C lies closest to the optimal social trade-offs, it is possible that Industry A is responsible for the vast majority of innovation in society. Even in this circumstance, however, we would still want patent law to account for the true exclusivity costs of

175. The patent system is not precisely uniform across industries—certain statutes are industry-specific, and some judicial law arguably varies by industry as well. Kesselheim, *supra* note 48 (discussing pharmaceutical specific patent laws, including the Hatch-Waxman Act); Dan Burk & Mark Lemley, *Is Patent Law Technology-Specific?*, 17 BERKELEY TECH. L.J. 1155, 1156 (2002) (arguing that the Federal Circuit provides different patent law for different industries). This variation, however, is sufficiently limited such that industries perceive largely uniform law. Long, *supra* note 83, at 48.

176. Lemley, *supra* note 129, at 150; *see also Mayo Collaborative Servs.*, 132 S. Ct. at 1294 (noting how patent law affects differently industries differently).

patenting, and following Industry C's patent law preferences would accomplish this goal. It is true that this may reduce Industry A's net incentives to innovate, but it will only reduce them to the socially optimal level. Stated another way, even if Industry A produces the dominant amount of innovation in society, we still want patent law that balances both the full incentives and the full exclusivity costs of that innovation.[177]

Second, proxy analysis can be applied to signal socially beneficial, industry-specific patent law. The TRIPS Agreement, to which the United States is a signatory, effectively mandates uniform patent and copyright systems in certain regards, and long-standing public policy is in accord.[178] However, were patent law to evolve to vary by industry, proxy signaling could be used among subindustries within each industry in much the same manner as it is introduced at the industry level here. Subindustries with different innovation characteristics could be analyzed to identify those subindustries that present socially desirable trade-offs for innovation within the industry. Patent law for the particular industry could then be modeled based on the proxy subindustry's preferences.

One of the primary critiques of industry-specific patent law is a concern about the increased opportunity for industry rent-seeking to set industry favorable patent laws.[179] Proxy signal analysis provides a way beyond this challenge by presenting objective means to identify the appropriate level of propertization within each industry. As noted, proxy analysis presents a technique to differentiate private patent law preferences that arise from a desire for greater rank-seeking from those that are based on a desire to actually increase incentives to innovate.

4. Measuring Industry Preferences

The proxy signals methodology assumes both that private industry will know its own preferences and that these preferences are identifiable. If, for example, the pharmaceutical industry is incorrect that stronger patent protection would be internally beneficial, this would send an inaccurate

177. Furthermore, in the United States, none of the innovation industries discussed represents such a dominant position in innovation overall that weighting would become necessary. *See, e.g.*, BUREAU OF ECON. ANALYSIS, U.S. DEP'T OF COMMERCE, INDUSTRY ECONOMIC ACCOUNTS (2012), *available at* http://www.bea.gov/industry/ (providing a wealth of data on the sizes of various industries in the United States, indicating that none of the industries discussed here represent a dominant position).

178. Agreement on the Trade-Related Aspects of Intellectual Property Rights, Apr. 15, 1994, 33 I.L.M. 81 (1984).

179. Long, *supra* note 83, at 48; Wagner, *supra* note 86.

signal that the proxy approach would not be able to filter. The industries discussed here are highly sophisticated and wealthy actors that spend vast resources on innovation and have the best information available concerning the relationship between innovation and patent protection. In addition, focusing on industry and subindustry groups, rather than individual firms, reduces the probability of receiving inaccurate signals.[180] It is highly likely that these private entities will have a sufficiently accurate sense of their own industry innovation preferences.[181] In particular, this private industry knowledge is the best knowledge that society can expect to acquire on these matters.

Further, in most cases, lawmakers should be able to identify industry preferences sufficiently to gather valuable information from proxy signals. The industries discussed here spend billions of dollars on intellectual property advocacy.[182] This advocacy, in the form of legislative and executive branch lobbying, judicial litigation efforts, and industry position papers and statements, is often public. Although certain lobbying takes place behind closed doors, the recent spate of patent cases before the Supreme Court and various patent reform legislation efforts have left a well-documented trail of amicus briefs and lobbying activity in which each of the industries discussed here has taken positions on multiple issues, producing a valuable public record. Conventional wisdom is that the signals from industry's advocacy efforts are not informative because they are too noisy, as it is impossible to separate their self-interested private interests from the social interest. The proxy approach provides a unique noise reduction method to extract the desired signal.

From this perspective, proxy signal analysis may be viewed as a more modest political proposal than it first appears. Legislators have long asked pertinent private industry actors for their opinions on how a particular

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180. *See* HADFIELD, *supra* note 17, at 23 (discussing the superiority of private markets for accurately processing information).

181. That said, both agency and behavioral concerns certainly can prevent firms from promoting their own best interests. Agency effects could lead private decision-makers within firms to act in their own best interests, rather than the firm's. Separately, the bounded rationality of human decision-making means that even well-meaning individuals may not act in the optimal manner to achieve their own preferences. Camerer, *supra* note 49. The study of the behavioral economics among groups is less developed than for individuals; in certain situations, group decision-making may tend to attenuate certain effects of bounded rationality. *Id.* at 14–16; Gregory M. Mandel, *Patently Non-Obvious: Empirical Demonstration that the Hindsight Bias Renders Patent Decisions Irrational*, 67 OHIO ST. L.J. 1391, 1414 (2006). Even where a firm misunderstands its own preferences, however, it is still likely to have better information than public entities. Further, focusing on subindustries should help ameliorate some of these concerns.

182. Lindsay R. Mayer, *Drug Makers Cash in on Lobbying Efforts*, OPENSECRETSBLOG: INVESTIGATING MONEY IN POLITICS (June 18, 2009); Kesan & Gallo, *supra* note 54, at 1359.

legislative proposal might affect them and whether they support it. In current practice, wealthy and powerful interests often have access advantages and routinely drown out competing voices to obtain inappropriate influence.[183] A perhaps lucky facet of recent patent reform debates is that powerful industries have lined up against each other on opposing sides of many disputes.[184] This face-off has produced a significant degree of deadlock on patent legislation. In copyright, where this has not been the case, several copyright industries have successfully lobbied for increasingly stronger protection,[185] though the recent legislative confrontation concerning the Stop Online Piracy Act[186] (SOPA) and the Protect IP Act[187] (PIPA) indicates that the long history of industry uniformity in the copyright context may be shifting. In each case, however, just because an industry is wealthy or powerful hardly means that that it will tend to advocate for laws in the social interest. Proxy analysis provides a different public choice framework to identify which private entities public lawmakers should listen to. Rather than selecting influence based on resources and access, proxy analysis proposes selecting influence based upon how likely it is that certain advocacy accurately reflects societal objectives.[188]

One way to envision operationalizing the proxy approach would be to place the burden on an advocate to demonstrate both that it accurately reflects a particular industry's position and that the industry faces similar trade-offs to society as a whole. This information-forcing approach[189] would produce great incentives for industry to divulge previously private information about the relationship between innovation and intellectual property law. Obviously, industry actors would have incentives to only disclose advantageous information, but this would still be a start. Proxy

183. LIBECAP, *supra* note 54, at 27 (noting that the political influence of private parties depends in part on their wealth); Kesan & Gallo, *supra* note 54 (discussing the effects of wealth and power on lobbying with respect to patent legislation).

184. *E.g.*, Kesan & Gallo, *supra* note 54, at 1347–57; BURK & LEMLEY, *supra* note 13, at 4.

185. *See* Paula Baron, *Symposium: Interdisciplinary Conference on the Impact of Technological Change on the Creation, Dissemination, and Protection of Intellectual Property: The Moebius Strip: Private Right and Public use in Copyright Law*, 70 ALB. L. REV. 1227, 1245 (2007).

186. H.R. 3261, 112th Cong. (2011).

187. S. 968, 112th Cong. (2011).

188. In this regard, proxy signals could produce efficiency savings in lobbying efforts. Instead of the current system that effectively makes lobbying power a function of resources—incentivizing a lobbying arms race, proxy signals would allow for a reduction in lobbying efforts, saving resources that could instead be used to finance greater innovation activity.

189. *See* Bradley C. Karkkainen, *Information-Forcing Environmental Regulation*, 33 FLA. ST. L. REV. 861 (2006) (discussing how environmental regulations can be structured to provide industry incentives to disclose private information).

signals present valuable means to begin to parse the complex political economy of intellectual property law.

5. Selecting Innovation Characteristics

One concern with proxy analysis may be that it appears to be circular in a certain respect: If we know what the social or legal objective is in the first instance, why not just implement it directly? The answer to this concern is that there is a significant difference between knowing what the social or legal objective is and being able to design laws to produce it. It is one thing to recognize that intellectual property law should balance the incentive benefits and exclusivity costs of protection in order to optimize incentives to innovate. It is another thing to know what particular laws will achieve this balance. Proxy signal analysis is based on the realization that it is easier to identify subindustries that, due to their technological and innovation characteristics, face equivalent trade-offs to society than it is to parse the relationship between patent law and innovation directly. This is not to claim that proxy signals will produce perfectly optimal law—there undoubtedly will be noise and distortions in the signals—but that the signals can provide better information than is currently available concerning socially preferable patent law.

Proxy signal analysis depends on accurately selecting the industry characteristics that are most pertinent to patent propertization preferences, and on accurately evaluating the relationship between these industry characteristics and societal innovation trade-offs. These assumptions appear substantially feasible for patent law, though this conclusion may vary in other fields. The industry characteristics examined here for innovation industries are well-recognized and have been well-studied over the past decade.[190] Similarly, the inferences drawn from them have either been empirically investigated or appear relatively straightforward.[191] With that said, the list of characteristics discussed here may be incomplete, and there may be some disagreement concerning how particular characteristics are evaluated.[192] As patent proxy analysis advances, greater expertise in

190. *See, e.g.*, BURK & LEMLEY, *supra* note 13; BESSEN & MEURER, *supra* note 23, at 120–64, 187–214; Burk & Lemley, *supra* note 6.

191. *See, e.g.*, BURK & LEMLEY, *supra* note 13; BESSEN & MEURER, *supra* note 23, at 120–64, 187–214; Burk & Lemley, *supra* note 6.

192. For example, while we desire patent law to take into account the social waste of duplicate development costs, this would be a difficult balance to achieve. Firms take into account a proxy for such costs in considering their likelihood of prevailing in a patent race, but identifying the optimal level of competition from a patent race perspective presents a very complex question. *See, e.g.*, Ted M.

the form of additional empirical data and particular industry experts could be brought to bear on these issues. Such expertise would be particularly valuable as the method is refined to apply to smaller subindustries.

An additional advantage of proxy signaling is that it would be hard for an industry to game the system. A great challenge in many legal debates is the informational asymmetry that exists because private actors often possess the greatest information concerning the likely effects of any legal change, but are incentivized to selectively disclose and portray that information in a light most favorable to their own interests.[193] In intellectual property law, private industry has the strongest information concerning the relationship between innovation and intellectual property law, but incentives only to portray the information in the manner most favorable to the industry's intellectual property wishes. Industry innovation characteristics, however, are information that generally is not confidential and that would be extremely difficult to manipulate. In particular, such information is both more publicly available and easier to evaluate than industry information on the relationship between innovation and intellectual property law. Similarly, because proxy signaling is based on identifying industries where interests align with society's there would be little reason for any selected industry to strategically game its advocacy. It will be in the identified industries' own self-interest to accurately disclose their information and preferences.[194] Certainly, industries that do not present socially optimal trade-offs will try to argue that they possess different characteristics. It is far easier, however, for public policy-makers to see through such charades and evaluate publicly available industry characteristics than it is to divine asymmetrically hidden private innovation information.

Sichelman, *Quantum Game Theory and Coordination in Intellectual Property* (2010), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1656625; John F. Duffy, *Rethinking the Prospect Theory of Patents*, 71 U. CHI. L. REV. 439 (2004).

193. Wendy Wagner & David Michaels, *Equal Treatment for Regulatory Science: Extending the Controls Governing the Quality of Public Research to Private Research*, 30 AM. J.L. & MED. 119, 148 (2004); David Dana, *When Less Liability May Mean More Precaution: The Case of Nanotechnology*, 28 UCLA J. ENVTL. L. & POL'Y 153, 159 (2010).

194. That said, industries with non-optimal innovation characteristics could try to bribe industries with optimal characteristics. This is particularly a risk to the extent that an industry with optimal characteristics represents a small share of the innovation market, rendering it less expensive to pay-off. In addition to potential fraud and other civil and criminal liability, there are other means to mitigate such concerns. For example, multiple sub-industries can be used as checks, and implementation of proxy signaling need not involve full transparency in the industry identification process.

6. Extraterritorial Innovation

The analysis presented to this point assumes a closed system of innovation. That is, a system in which there is no net inflow of innovation from another jurisdiction or net outflow to another jurisdiction. In reality, United States industry both relies on innovation produced outside the jurisdiction and profits by selling its own innovation extraterritorially. A society that is a heavy net consumer of external innovation would be expected to favor low levels of intellectual property propertization, preferring to take advantage of the positive externalities of innovation produced by others. This is one of several reasons that less developed countries may often favor weaker intellectual property rights regimes.[195] Such countries prefer to piggyback on others' innovations, but have limited technological innovation of their own from which they could derive benefit through intellectual propertization. The proxy approach, therefore, would not produce accurate results for a jurisdiction that is a significant net consumer of innovation.

The converse, however, is not true. A society that is a heavy net producer of innovation, which can be commercialized extraterritorially, will not favor artificially high domestic intellectual property protection because intellectual property laws are national. Having stronger United States patent law will not help American industry profit from foreign innovation sales because the ability to profit from innovation overseas largely depends on foreign countries' intellectual property laws, not domestic laws.[196] This circumstance may (and apparently does) cause domestic industry to advocate for stronger patent protection abroad, but not domestically.[197] To the extent United States industry is either neutral in its production of innovation, or is a net producer of innovation, the methodology presented here will hold. This presumption is supported by substantial empirical evidence.[198]

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195. Eric Ford & Nicholas Taylor, *Free and Open Source Software in Developing Countries*, 17 U. BALT. INTELL. PROP. L.J. 139 (2009).

196. It is theoretically possible that stronger United States law could be used as a basis to argue for stronger intellectual property protection abroad, and therefore that industries may advocate for stronger United States protection than they would in the absence of the opportunity to profit extraterritorially. This possibility could be resolved by analyzing the net consumption/production of innovation characteristic to account for external production.

197. *See* Susan K. Sell, *TRIPS was Never Enough: Vertical Forum Shifting, FTAs, ACTA, and TPP*, 18 J. INTELL. PROP. L. 447 (2011) (discussing U.S. policy of steadily pushing for stronger intellectual property protection in foreign countries).

198. Robert D. Atkinson & Daniel D. Castro, *A National Technology Agenda for the New Administration*, 11 YALE J.L. & TECH. 190 (2008).

7. Real World Limitations

Finally, there may be one unavoidable limit to the proxy signal approach. Because proxy analysis relies on the characteristics of real world industries, it is limited by the availability of industries with given characteristics. No industry (or subindustry) is likely to precisely mirror optimal social trade-offs between incentives and exclusivity.[199] As a result, no industry will produce a perfect signal. Ironically, this limitation arises because the real world is not complex enough—precisely the opposite of the problem that has plagued prior analysis. The more heterogeneous industries and subindustries are, the more useful information can be derived from proxy signals.

Even without a single ideal industry or subindustry, we can still obtain valuable signals. For subindustries with many socially equivalent trade-off characteristics, but certain nonequivalent ones, we usually will be able to detect the direction of the bias caused by the nonequivalent characteristics. By engaging in this exercise for multiple subindustries with nearly equivalent characteristics, it will be possible to combine this information to home in on a socially preferable level of patent propertization. Though the final results will not be perfect, they can provide far superior information than is currently available concerning socially optimal rights, based on the best existing public and private resources and information.

Unlike conventional law and economics analysis, which makes numerous simplifying assumptions about real world innovation in order to try to identify socially optimal levels of propertization, proxy signal analysis recognizes real world complexity as an unalterable given, and employs this heterogeneity as a previously untapped goldmine that can be leveraged for insight into socially preferable legal regimes. Where most prior economic analysis deals with trying to design a hypothetical ideal version of patent law in the abstract,[200] the proxy technique is concerned

199. Even industries that align with social preferences on most or all innovation characteristics may still differ from societal objectives in certain regards, such as biases for short-term over long-term returns, against uncertainty, or for appropriable types of innovation. *See, e.g.*, Grossman, *supra* note 128 (discussing corporate biases towards short-term goals). Attention to industry characteristics, however, can mitigate at least some of these biases. For example, industries with longer development time periods can be considered to assure that proxy signaling takes into account long-term incentive preferences.

200. *E.g.*, Bessen & Maskin, *supra* note 46; Hunt, *supra* note 46; Dasgupta & Stiglitz, *supra* note 46; Scotchmer, *supra* note 41; Merges & Nelson, *supra* note 30; Kitch, *supra* note 45. Some empirical economic work attempts to evaluate whether current patent law is stronger or weaker than the optimal level, but can only identify a direction and not how far the law is from the ideal.

with how to modify law in relation to the status quo, a more practical result for real world decision-making.

In this manner, the proxy method provides a partial solution to the public-good market failure problem in patent law. Because innovation is a public good, there is a well-recognized failure of the market to provide accurate signals concerning how much innovation consumers desire.[201] While quantity demand can be used to signal the intensity of consumer preferences for most goods, this mechanism does not work for public goods.[202] In addition, there often is no way to use prices to signal consumer preferences because consumers have incentives to understate their preferences in this regard (so as to free ride at a lower price).[203] Thus, society needs an alternative mechanism to identify how much of a public good to produce.

Proxy signaling can provide this method. Rather than trying to identify the optimal quantity of innovation to produce directly, it may be possible to do so through proxies. An industry that faces the same innovation trade-offs as society as a whole will tend, as described above, to prefer a socially beneficial level of innovation incentives. Molding patent law consistent with the preferences of such an industry should produce a socially appropriate level of incentives, to a first order approximation, even though we are not able to measure consumer quantity demand or pricing preferences directly. This effectively occurs because an industry that faces the socially desired trade-offs between incentives and exclusivity is actually both a producer and a consumer of innovation. In playing both roles, such entities will necessarily take the true intensity of their own consumer preferences into account.[204]

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201. FRISCHMANN, *supra* note 39, at 53–57; John P. Conley & Christopher S. Yoo, *Nonrivalry and Price Discrimination in Copyright Economics*, 157 U. PA. L. REV. 1801, 1810 (2009); Paul A. Samuelson, *A Pure Theory of Public Expenditure*, 36 REV. ECON. & STAT. 387 (1954). Public goods are traditionally defined as goods that are nonexcludable (cannot be provided to one without providing them to all) and nonrivalrous (consumption by one does not reduce the available supply). Conley & Yoo, *supra* note 201, at 1805. Absent intellectual property protection, innovation is a public good because it is nonexcludable and nonrivalrous.

202. *Id.* at 1808–10. The indivisibility of public goods, in the sense that the quantity of the goods produced can vary, but every consumer will consume the entire output, means that quantity generally cannot be used to identify the intensity of consumer preferences. *Id.*; Kenneth J. Arrow, *Economic Welfare and the Allocation of Resources for Invention*, *in* THE RATE AND DIRECTION OF INVENTIVE ACTIVITY 609 (Richard Nelson ed., 1962).

203. Conley & Yoo, *supra* note 201, at 1810. Note that even if a producer can exclude consumers (as with intellectual property protection), the producer still will not know how much to charge consumers.

204. As noted above, optimizing innovation is not necessarily the same as optimizing social welfare, which is why the signaling method is not a complete solution to the public good problem.

CONCLUSION

The proxy signal methodology introduced here presents a new way to think about public choice and social welfare analysis. Rather than relying on an improbable hope that public actors will be all-knowing about the interaction between patent law and innovation, proxy analysis provides concrete means to capture collective information through a form of fine-tuned crowd-sourcing to take advantage of the vast warehouse of private and market knowledge concerning innovation. This approach can be generalized beyond its initial application here, in certain contexts, to take into account equitable concerns and to apply to other legal domains beyond patent law.

A common concern with traditional law and economics approaches to legal issues is the primary focus on efficiency.[205] Numerous commentators have critiqued the goal of trying to achieve the most efficient allocation of resources for its distributional agnosticism and failure to take into account equitable concerns.[206] Though the proxy methodology is developed in the context of the efficiency trade-off between incentives and exclusivity, this approach can be managed in certain circumstances to pursue equitable objectives as well. Preferred equitable objectives can be sought in the same manner as described above—by selecting appropriate characteristics. In the context of patent law, for example, particular innovation characteristics may lead private actors to prefer certain types of innovation over others, which may have social consequences. For example, to the extent there is concern that the patent system incentivizes firms to produce innovation that excessively benefits wealthier economic classes, while not incentivizing enough innovation that is beneficial to those who are less well off, proxy analysis could be used to adjust incentives by selecting proxies that accord with particular social objectives.[207]

Proxy signal methodology may also be applied beyond patent law to other legal domains where there are generally agreed upon normative goals but widespread disagreement concerning how to achieve those goals.

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205. *See generally* RICHARD A. POSNER, ECONOMIC ANALYSIS OF LAW 11–15 (7th ed. 2007) (noting that "efficiency . . . has limitations as an ethical criterion for decisionmaking" and discussing other objections to utilitarianism); AVERY W. KATZ, FOUNDATIONS OF THE ECONOMIC APPROACH TO LAW 344–409 (1998) (presenting a series of critiques to an utilitarian economic approach to law).

206. *See, e.g.*, James R. Hackney Jr., *Law and Neoclassical Economics Theory: A Critical History of the Distribution/Efficiency Debate*, 32 J. SOCIO-ECON. 361 (2003) (tracing the history of the distributional critique of law and economics); POSNER, *supra* note 205, at 11–15 (discussing the "limitations [of efficiency] as an ethical criterion of social decisionmaking").

207. Dan Hunter, *Culture War*, 83 TEX. L. REV. 1105, 1116 (2005).

The application of proxy analysis is context-dependent, requiring situations where varied private actors both possess superior information to society on how to balance certain trade-offs and where such private entities can be objectively evaluated to identify those facing similar trade-offs to society. Successful proxy analysis also requires that private entities possess diverse characteristics that have traceable effects on varying positions with respect to the law and that interests on each side of an issue are sufficiently concentrated so as to send a signal.

Copyright law presents a potentially fruitful area for future proxy analysis.[208] The copyright market includes a wide diversity of industries for study, including motion pictures, music recording, publishers, broadcasters, the Internet, and visual and graphic arts. These industries possess different innovation and market characteristics, just as with the patent industries, which can be evaluated with respect to the social equivalence of trade-offs. Copyright proxy analysis would be more complicated than patent due to the greater debate over non-utilitarian objectives, particularly first amendment and moral rights.[209] But, copyright law would also provide a potentially intriguing counterpoint to patent analysis in several regards, including concerning certain software and information technology industries that generally desire weak patent rights but stronger copyright protection.

Proxy analysis could apply to certain issues in other areas of private and public law. For example, some areas of contract law involve private entities that regularly encounter the trade-off between the benefit of contract law protection and the cost of others exercising their contract rights. In certain of these cases, private preferences will depend upon identifiable industry characteristics, such as the propensity for breach in the industry, whether the industry is diffuse or concentrated, and levels of contract enforcement in the industry, which could be mined for proxy information.[210] In a different vein, the current debate over greater financial regulation in the wake of the recent economic crisis has exposed a number

208. *See, e.g.*, William M. Landes & Richard A. Posner, *An Economic Analysis of Copyright Law*, 18 J. LEGAL STUD. 325, 326 (1989) ("Striking the correct balance between access and incentives is the central problem in copyright law.").

209. *See, e.g.*, Amy M. Alder, *Against Moral Rights*, 97 CAL. L. REV. 263 (2009) (discussing the moral rights debate in copyright law).

210. Note that application of proxy signals in contract law is different from contract default rules, which are based on allocating rights in the manner the parties would have tended to agree to *ex ante*. POSNER, *supra* note 205, at 97, 99 (7th ed. 2007). Proxy signaling recognizes that following average private party tendencies may not produce a socially optimal result, and instead relies on selecting particular private parties whose preferences are expected to mirror society's.

of rifts within the financial industry concerning different preferences for financial reform and financial regulation. Various parts of the financial industry have taken different positions on issues ranging from mortgage reform to proprietary trading restrictions and the establishment of the Consumer Financial Protection Bureau.[211] These varied positions are likely produced in part by differing industry characteristics, which could be studied and evaluated in order to better understand the merit of various reform proposals from a social perspective.

Proxy signal methodology thus presents a new technique for addressing a central question in many areas of law: how to identify the socially optimal balance among competing trade-offs. Parsing private industry characteristics to select proxies who face similar trade-offs to society allows us to identify private parties who are expected, for self-interested reasons, to advocate for socially beneficial balances in law. These private parties' actions can be mined to bring extensive private financial and informational resources that have never been captured before to bear on complex legal issues. Though necessarily stylized for purposes of development in this article, proxy signal analysis introduces a powerful new form of law and economics that can leverage the real world complexity of heterogeneous actors pursuing their own best interests in a manner to identify socially beneficial legal regimes.

211. *Compare* ABA STATEMENT ON HOUSE PASSAGE OF DODD-FRANK BILL (June 30, 2010), *available at* http://www.aba.com/Press+Room/063010HousePassageDoddFrankBill.htm (American Bankers Association criticizing proposed Dodd-Frank Act concerning financial regulatory reform, stating "This bill will do severe damage to traditional banks and to Main Street"), *with* RYAN STATEMENT ON ENACTMENT OF DODD-FRANK ACT (July 21, 2010), *available at* http://www.sifma.org/news/news.aspx?id=17722 (Securities Industry and Financial Markets Organization supporting passage of Dodd-Frank Act as "an important step forward for America's financial markets and its economy").