INTELLECTUAL PROPERTY AND THE ORGANIZATION OF INFORMATION PRODUCTION

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Abstract

Standard economic analysis of intellectual property assumes that all information producers are affected similarly by changes in the scope of legal protection afforded intellectual products. This paper relaxes this assumption, and endogenizes the effects of changes in intellectual property rights on production strategies used by information producers. I specify the components that contribute to the costs and benefits of information producers, and analyze how different combinations of these components can sustain varied strategies for producing information. Given diversity in production strategies, I suggest that changes in intellectual property rules alter the payoffs to information production in systematic and predictable ways that differ as among strategies. My conclusion is that expansion of intellectual property rights is likely to increase the prevalence of commercial producers who integrate new information production with management of large-scale owned-information inventories, at the expense of individual authors and small-scale information producers, commercial organizations that make information they produce freely available and indirectly appropriate the benefits of its production, and noncommercial producers like universities and amateurs. These observations have two primary policy implications. First, increasing property rights protection is likely to be inefficient more often and sooner than the standard model predicts. Second, decisions about intellectual property rules systematically entail normative choices about the type of organizations that will produce information in society and the types of incentives they respond to.

I. INTRODUCTION

As the centrality of information production to our economy becomes clearer, some in the legal literature argue that an efficient information economy requires ever-

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stronger property rights in information.[1] This claim is inconsistent with accepted economic models of intellectual property. Moreover, in a digitally networked environment with low communications costs, many and varied information production strategies are being developed and used by diverse producers—professional and nonprofessional, commercial and noncommercial, on large and small scales. In this paper I explain how recognizing this diversity modifies the standard economic model of the effects of intellectual property on information production, and this modification further challenges the assertion that more property rights are necessary to drive the information economy. The analysis also underscores the normatively interesting implications of such rights for the organization of information production in our society.

According to the standard economic model,[2] information is a public good: once produced, it is purely nonrivalrous[3] and partially non-excludable.[4] Moreover,

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[1] Possibly the most extreme instance of this claim concludes a recent book by Paul Goldstein, probably the leading doctrinalist who uses economic arguments to interpret copyright law:

> "The best prescription for connecting authors to their audiences is to extend rights into every corner where consumers derive value from literary and artistic works. . . the results should be to promote political as well as cultural diversity, ensuring a plenitude of voices, all with the chance to be heard."

Paul Goldstein, Copyright's Highway, From Gutenberg to the Celestial Jukebox 236 (1994).

[2] Most economic analysis of intellectual property was developed in reference to, and has focused on innovation and the patent system, not on copyright. The canonical welfare economics discussion of patents is Kenneth J. Arrow, Economic Welfare and the Allocation of Resources for Invention, in The Rate and Direction of Inventive Activity: Economic and Social Factors 609, 616-17 (National Bureau of Economic Research, 1962). The canonical statement of the standard model with respect to copyright is William M. Landes & Richard A. Posner, An Economic Analysis of Copyright Law, 18 J Legal Stud 325 (1989), although there are some early discussions of the economics of copyright: Arnold Plant, The New Commerce in Ideas and Intellectual Property (1953); Robert M. Hurt & Robert N. Schuman, The Economic Rationale of Copyright, 56 A, Econ. Rev. Papers. & Proc. 42 (1966); Stephen G. Breyer, The Uneasy Case for Copyright: A Study of Copyright in Books, Photocopies, and Computer Programs, 84 Harv. L. Rev. 281 (1970); and influential economic discussions of fair use, Wendy Gordon, Fair Use as Market Failure: A Structural and Economic Analysis of the Betamax Case and Its Predecessors, 82 Colum. L. Rev. 1600 (1982); William W. Fisher III, Reconstructing the Fair Use Doctrine, 101 Harv. L. Rev. 1659 (1988).

[3] This means that additional uses of an existing unit of information can be made without diverting resources from other economic activity, except insofar as necessary to communicate the information to the additional user. That positive cost is *the cost of communication* of the information, not the marginal cost of an additional use of the information.

[4] Paul Romer, Endogenous Technological Change, 98(5) Journal of Political Economy, S73-S74 (1990). Every economic good can be defined by the degree to which it is excludable, and the degree to which it is

information is both input and output of its own production process.[5] Because of the nonrivalrousness of information, the optimal demand price for using information that already exists—both for end-consumption and as an input to new production—is zero.[6] If users—including producers who use the information as an input—see a positive price, they will under-utilize available information. Economists therefore generally agree that too much protection will result not only in decline of consumer welfare per existing work (in a static analysis)[7] but also in a decline in the production of new works (in a dynamic analysis) because of underutilization of information inputs by producers.[8]

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rival. A good is excludable to the extent that its producer can appropriate its benefits by excluding those who benefit from it unless they pay a price. A good is rivalrous to the extent that its use by one person prevents (rivals) its use by another person. The former is a function of the available technology for exclusion, and the institutional (legal) framework that permits or facilitates such technically feasible exclusion. The latter is purely "technological." It is an attribute of the good itself, that either can or cannot, as a practical matter, be used by many people without degradation or rivalry. A pure private good is one that is excludable and rivalrous. A pure public good is one that is nonexcludable and nonrivalrous. When a good is public in the sense of being nonexcludable, it is so because no firm can capture the social value of its provision. It must therefore be provided publicly, if at all. By definition, a nonrivalrous good is one that can be used by one person without preventing or degrading its use by any other person. Any additional person who uses the good imposes no social cost. Its optimal demand price is therefore zero. At that price, it would not be produced by private interests, and must be provided publicly. At a higher price that would induce private production, it will be under-consumed, and hence under-produced.

[5] "Information is not only the product of inventive activity, it is also an input—in some sense, the major input apart from the talent of the inventor." Arrow, *supra*, at 618.

[6] "In the first place, any information obtained, say a new method of production, should, from the welfare point of view, be available free of charge (apart from the cost of transmitting information). This ensures optimal utilization of the information, but of course provides no incentive for investment in research." Arrow, Economic Welfare and the Allocation of Resources for Invention, 616-17. Arrow's point about the cost of transmission refers to the fact that the use of wood for pulp, rather than chairs, makes books, as distinguished from the intellectual content they communicate, private goods, not public goods. Their value as collections of paper is, however, protected by traditional property law—criminal prohibitions on theft and such. It is only the value of the information content that is protected by copyright, which prevents reproduction of the content, not resale of the pulp. Selling books at the marginal cost of the copy would not compensate the author's investment, only the printer's.

[7] Landes & Posner, at 333-36.

[8] On the importance of the central role of information as input see also Suzanne Scotchmer, Standing on the Shoulders of Giants: Cumulative Research and the Patent Law, 5 J. of Economic Perspectives 29-41 (1991). Arrow suggests that the demand of producers for information inputs is likely to be even more suboptimal, given a positive price on information, than demand of producers of other commodities with an informational component, because both (a) it is much more difficult to identify, and hence to appropriate, subsequent information-production uses of information, and (b) the value of information inputs in producing information outputs is even more conjectural. Arrow, *supra*. See also Landes & Posner, at 332.

The standard model assumes that intellectual property rights affect all information producers in the same ways. This paper traces the implications of relaxing that assumption. Part II introduces the basic intuition that if, as we seem to see around us, information producers actually use diverse strategies to acquire information inputs and manage information outputs, then intellectual property law will have different effects on different strategies. Some producers will benefit, while others lose. I briefly describe examples from the software and genetic engineering fields of how different strategies can be observed in competition with each other in pursuit of the same innovative activity, and how they might be differently effected by intellectual property. Part III develops an *ex ante* analysis of how this diversity arises and how changes in intellectual property are likely to affect payoffs to various strategies. I suggest a set of parameters that specify the costs and benefits to producers from information production. These parameters can be combined in different ways, enabling the diversity of strategies open to producers to sustain positive welfare from information production. Part IV then abstracts nine ideal-type strategies that organizations in our economy use to produce information, which accords with the (scarce) empirical literature that describes information production. Part V suggests how changes in intellectual property rights affect the payoffs to these strategies in predictable ways. Increased protection makes some strategies more attractive and others less so. Specifically, increased protection benefits commercial information producers that vertically integrate new production with management of large-scale owned inventories of existing information. This benefit comes at the expense of alternative strategies, both commercial and noncommercial. In Part VI I note a series of feedback effects likely to result from the shifts in organizational strategies that the

analysis in Part V predicts. These feedback effects will likely amplify, speed up, and lock in the effects of the changes in payoffs identified in Part V.

Part VII explains the two primary policy implications of this analysis. First, traditional economic analysis will systematically overestimate the benefits of any particular proposed increase in intellectual property rights. This upward bias occurs because traditional analysis does not account for decreased production by organizations using strategies that do not benefit from increased protection, but suffer the increased costs it imposes, and because those organizations that prosper most in an increasing-rights environment have systematic incentives to misallocate their human capital. Second, any given level of aggregate production might, in principle, be achievable through a number of different mixes in production strategies. An increase or decrease in intellectual property rights may have no meaningful aggregate effects, while affecting the mix of strategies used for production. A society is likely to have normative commitments that would lead it to prefer one mix to another. There may be good reasons, for example, to prefer a high ratio of market to nonmarket organizations involved in information production, or vice versa. This type of social choice between different mixes of information production strategies is political, and cannot be made by using purely economic analysis.

II. RECOGNIZING DIVERSITY IN INFORMATION PRODUCTION STRATEGIES

The standard model assumes that intellectual property rights similarly affect all information producers—they can all appropriate the benefits of their efforts more efficiently, and must all pay higher prices for their information inputs. In this paper I

relax this assumption. The basic intuition is that different organizations, with different strategies for producing information, are affected differently by different sets of property rights in information. The analysis suggests an endogenous explanation of how changes in these rules can cause information producers to change the ways in which they seek information inputs and the ways in which they appropriate the benefits of their productive activity. The core concept is that changes in property rules make some strategies for organizing production more attractive than others, and drive organizations and individuals to adopt those models of production best suited to take advantage of the property rights regime in place.[9] This is a different approach than the one used in the literature that empirically studies information production strategies, because that literature seeks through qualitative and quantitative analysis to describe how firms actually use property rights and does not analyze the relationship between the structure of property rights and the strategic choices of the studied firms.[10] It is also different from the neo-Schumpeterian literature[11] that focuses on the relationship between market structure and investment in innovation, which, whether it treats market structure as

[9] A remotely related critique of intellectual property rights is that they skew production in the direction of protected materials, and away from unprotected materials—for example towards mass-appeal entertainment and away from factual news. Glynn Lunney, The Economic Structure of Copyright, 49 Vand. L. Rev. 483 (1996); C. Edwin Baker, Giving the Audience What it Wants, 58 Ohio St. L. L.J. 311, 326-27 (1997). The analysis offered here differs from these critiques in that those are direct incentives-arguments, and focus on how specific rules give greater protection to certain kinds of works—in this case, the greater protection given fanciful works relative to factual works—and skew incentives to produce protected content over unprotected content. The focus of this paper is on the effects of rules on incentives for organization of production, and its predictions as to implications for content occur through organizational adaptations, not directly through incentives.

[10] The two most wide-ranging empirical studies are quite old by now, Richard C. Levin, Alvin K. Klevorick, Richard. R. Nelson, Sidney G. Winter, Appropriating the Returns from Industrial Research and Development 3 Brookings Papers on Economic Activity 783, 794-96 (1987); and Edwin Mansfield, Mark Schwartz, and Samuel Wagner, Imitation Costs and Patents: An Empirical Study, 91 The Economic Journal 907-918 (December 1981).

[11] For a compact review of this literature see F.M. Scherer, Schumpeter and Plausible Capitalism, 30 Journal of Economic Literature 1416-33 (1992).

exogenous or endogenous, does not focus on the effects of intellectual property rules on the organization of production at the firm level.

The diversity of information production strategies, the competition between them, and the divergent effects that intellectual property rules have on them is be illustrated by examples from the software and genetic engineering industries.

Computer communications, software and standards are a sector in which strategies that do not depend on intellectual property have often outperformed those that do. TCP/IP and the public network model of the Internet overwhelmed the proprietary networks like Prodigy, Compuserve, and MSN. Ethernet was developed at Xerox PARC as a public standard intended to enhance networking (appropriated indirectly through sale of networked printers and copiers). It became the dominant LAN standard despite IBM's attempt to establish its proprietary Token Ring standard in the 1980s. The World Wide Web was developed by a scientist then working at CERN, Tim Bernhers Lee, as a device to share information with and among colleagues. Lee treated the standard from its inception as public. Current standard setting is achieved through a noncommercial body, the W3C, which is sponsored by two academic institutions, organized by Lee, and includes over 200 commercial, academic, and governmental organizations. It, rather than a proprietary program like Lotus Notes, became the standard for document sharing.

Perhaps most telling about the force of appropriation strategies that do not rely on intellectual property in software development is the remarkable success of open source strategies. Among many other programs, open-source strategies are responsible for the Apache Web server software,[12] whose growth exceeded that of competing commercial

[12] On the Apache project see http://www.apache.org/.

products between 1995-1998. It is already used by over 50% of web servers.[13] Sendmail, an open source e-mail relay program, is used by over 75% of Internet mail servers. Most widely known is the GNU/Linux operating system,[14] which has recently been touted as a viable competitor to Windows. Linux was paid the ultimate compliment when Microsoft recognized open source development strategy in general, and Linux in particular, as the primary credible threat to the dominance of its Windows operating systems, particularly to Windows NT.[15] Similarly, in the first half of 1999 IBM began focusing on Linux as the operating system for its servers, offering user support and publicly demonstrating Linux's exceptional efficiency.[16] The utility of open source strategies for software development more generally has been suggested by Netscape's adoption of such a strategy for its Navigator program[17] and Sun Microsystems' for its Java programming language.[18]

Open source development relies heavily on communication among volunteer users/developers.[19] An open source project will usually be started by a person or a group who write the basic software to perform a function, usually to solve a problem or need they have as users. Other users are then invited to use the software, and when they develop needs unfulfilled by the program, they post questions to mailing lists dealing with the particular type of software, and either they, or (usually) someone else in the

[13] See The Netcraft Web Server Survey, http://www.netcraft.com/Survey/
[14] See http://www.li.org. The operating system is more commonly called simply "Linux", after its kernel, but the whole project integrates large chunks that were developed as part of the GNU project, pioneered by Richard Stallman almost a decade before Linux was written.
[15] See The Halloween Memo, http://linux.miningco.com/library/blhalloween.htm; Lee Gomes, Microsoft Acknowledges Growing Threat of Free Software for Popular Functions, Wall St. J. (Nov. 3, 1998) B6.
[16] See Scott Berinato, Catering to the Linux Appetite, PC Week June 7, 1999. Vol 16, No. 23, p. 103.
[17] See Denis Caruso, Netscape Decision Could Alter Software Industry, N.Y. Times (Feb. 2, 1998).
[18] See John Markoff, Sun Microsystems is Moving to "Open Source" Model, N.Y. Times (Dec. 8, 1998).
[19] The description here relies on two widely recognized descriptions of open source strategy, its relative advantages, and what makes it tick, Eric Raymond, The Cathedral and the Bazzar (1998)

network of users/developers will provide a fix. To maintain the ability of users to add and develop the software, while retaining the benefits of these downstream additions for all those who preceded them, open source software is distributed with its source code, subject to a license: that permits redistribution, whether by sale or gift; permits derivative works if these are distributed under the terms of the original license; and allows authors to control integrity of the original code as a unit, but does not constrain parallel distribution of modifications.[20] These elements severely limit the ability of those who develop software on an open source model direct to appropriate the benefits of production by asserting intellectual property rights. Individuals and organizations that use this strategy must instead follow indirect appropriation strategies that do not rely on asserting intellectual property rights.

Open source strategies appear to have been particularly effective at producing robust, well-tested software. This is apparently so because this approach enlists a wide-ranging international community of developers operating from a variety of incentives—reputation, hobby, political commitment, or associated businesses—who test, improve, and service the software on a scale, at a rate, and with efficiency that cannot be replicated even by the largest software manufacturers. While the individual investment of most participants may be lower than that of any single developer in a commercial model, the combined efforts of individuals who use the product and contribute pertinent local solutions to the complex system appears to produce better solutions more rapidly than possible in more centralized production models.

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http://www.tuxedo.org/~esr/writings/cathedral-bazaar/, and Eric Raymond, Homesteading the Noosphere (1998) http://www.tuxedo.org/~esr/writings/homesteading/homesteading.html.

[20] I rely on the Definition of Open Source http://www.opensource.org/osd.html.

The potential conflict between open source and direct-appropriation strategies was most clearly stated in an internal Microsoft memo known as the "Halloween Memo."[21] There, the author suggested that Microsoft could compete with open source by developing new proprietary standard interfaces that would be necessary for Linux to interoperate with Microsoft-compatible products, and then to deny Linux developers access to those interfaces.[22] Similarly, standard-setting for the World-Wide-Web—which, from their inception, were developed and updated on a nonproprietary model—was recently shaken by two patents granted on basic elements of the current standards, asserted by participants in the standard setting process after their adoption.[23] So, while property rights can plainly harm open source software development, strong intellectual property protection holds little value for this approach to software development.[24]

Equally revealing about the relative efficacy and importance of production strategies that suffer from increases in intellectual property is the one told by Rebecca Eisenberg about the Human Genome Project, and the competing proprietary and non-proprietary strategies for pursuing complimentary DNA (cDNA) sequencing.[25] Patent

[21] http://www.opensource.org/halloween/halloween1.html.
[22] See discussion of decommoditizing protocols in the annotated Halloween document, http://www.opensource.org/halloween/halloween1.html#decommoditize.
[23] See Teresa Riordan, Microsoft Move Sparks Controversy Over Web Standards, Cybertimes February 22, 1999, describing how patents granted to Microsoft for cascading style sheets, Patent No. 5,860,073, granted January 19, 1999, and to Intermind Corp. on metadata tagging, Patent No. 5,862,325, granted January 19, 1999, raised concerns about future defections from the standards setting process.
[24] Open source software is usually released under a license intended to keep the code from being appropriated downstream. This is a strategy developed by the Free Software Foundation to permit a non-proprietary model to survive in a proprietary environment. Nonetheless, if the basic rules of the General Public License used by the Free Software Foundation or similar public licenses were incorporated as a limitation on intellectual property law, the developers would need no rights to sustain their production strategy, and would be protected from assertion of rights by others.
[25] Rebecca S. Eisenberg, Intellectual Property at the Public-Private Divide: The Case of Large-Scale cDNA Sequencing, 3 U. Chi. L. Sch. Roundtable 557 (1996). cDNA sequences are "copies of the coding regions within the genome that a cell is in the process of expressing, in effect creating a heavily redacted version of the genome that eliminates all of the 'junk DNA'." Id., at 558.

applications for many ESTs are still pending,[26] and the availability of strong property rights is unclear. Developers have nonetheless adopted a series of strategies for producing ESTs, ranging from highly property-rights reliant[27] to release of the information into the public domain with expectation of future associated revenues.[28] Particularly interesting is Eisenberg's description of Merck & Co.'s incentives for investing in a database dedicated from its inception to the public domain:

> "Merck's comparative advantage does not lie in performing this fundamental research, but rather in developing specific drugs at a later stage in the research and development process. By promptly placing the sequence information in the public domain, and thereby making it widely available to academic researchers, Merck anticipates benefiting in the long run from the fundamental research of those who use the database. Nothing obligates these researchers to bring any potential products to Merck for commercial development, but Merck is confident that its capabilities and resources will allow it to capture an adequate share of resulting products to justify its modest investment in generating the database. . . .
>
> From Merck's perspective, cDNA sequences are research tools for use in drug discovery, not products for sale to consumers. For HGS and Incyte, cDNA sequences are themselves a product . . .[29]

It is important to note that Merck's supply-side indirect appropriation strategy—funding information production, access to which will give Merck production advantages in its core markets—cannot, by itself, sequence genes. The strategy relies on, and aids, academic researchers by giving them access to information inputs they need in order to

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[26] ESTs, expressed sequence tags, are "a DNA sequence for a small portion of each cDNA. Each of these partial sequences, called an "expressed sequence tag" ("EST"), is long enough to supply a unique identification for the gene from which it derives, but short enough to permit rapid partial sequencing of a large number of genes. Any given EST can then be used as a probe to find its corresponding full-length cDNA for further study. A database of ESTs thus provides a catalogue of expressed genes that can serve as a useful resource in subsequent research to identify particular genes of interest and to study their biological functions. Eisenberg, *supra*, at 558.

[27] See Eisenberg, cDNA Sequencing, at 565-566, describing a collaboration between Human Genome Sciences, which develops sequences, and SmithKline Beecham, which would produce therapeutic and diagnostic products therefrom, and the Incyte Pharmaceuticals' database, LifeSeqk, which is intended to by licensed on a nonexclusive basis to multiple firms for development into products.

[28] Merck & Co. has funded a human cDNA sequencing project at the Genome Sequencing Center at Washington University to create a public-domain resource. *Id.*

[29] *Id.*, at 570-71.

sequence new genes. These researchers, in turn, appropriate the value of their information production indirectly, through personal gains—reputational, educational, hedonic—or through grant-funding and teaching tied to their information productivity. The scientists add the sequences they identify to the public domain, and rely on government grants and academic institutional funding, rather than on appropriation of the gene sequences they produce, to appropriate the benefit of their work. These forms of funding are tied to publication in scientific journals. The journals, in turn, reinforce the public domain focus of the academic model by requiring scientists who publish to make their methods and materials freely available to other scientists.[30]

If genomic research will (as Merck & Co. has bet) advance most rapidly if cDNA sequences are freely available in the public domain for researchers to use as tools in further research, and if open source strategies are better at producing at least some kinds of software than direct appropriation intellectual-property dependant strategies, then intellectual property rights in these areas are counterproductive. While these examples cannot establish which strategy is more efficient in the long term, they do suggest how there might be conflict between the interests of different organizations engaged in similar information production activities, based on how they organize their production. It is this

[30] Most expressly, this can be seen in the Extended Guide for Authors of *Nature*, which states "Papers reporting protein or DNA sequences . . . will not be accepted without a Genbank . . . accession number." See, *e.g.*, Nature Extended Guide to Authors, Section 5.3, available http://www.nature.com/Nature2/serve?SID=18717415&CAT=NatGen&PG=g2a/g2a.html#5. See also Science, Conditions of Acceptance ("Archival data sets (such as sequence and structural data) should be deposited with the appropriate data bank and the identifier code should be sent to Science for inclusion in the published manuscript (coordinates should be released no later than 1 year after publication).", available http://www.sciencemag.org/misc/con-info.shtml#conditions; Cell, ("Publication of a research article in Cell is taken to imply that the authors are prepared to distribute freely to academic researchers for their own use any materials (e.g., cells, DNA, antibodies) used in the published experiments. In cases of dispute, authors may be required to make primary data available to the Editor. Nucleic acid and protein sequences as well as X-ray crystallographic coordinates should be deposited in the appropriate database"), available http://www.cell.com/misc/itoa.shtml. GenBank is the NIH public domain depository for DNA sequences. See http://www.ncbi.nlm.nih.gov/genbank.

systematic competition among producers who use different strategies that this paper is concerned with. And my purpose is to uncover unseen inefficiencies, incentives and opportunities for rent-seeking legislation, and normatively unappealing effects by focusing on how these strategies are affected by intellectual property law.

III. INTELLECTUAL PROPERTY RIGHTS AND THE COSTS AND BENEFITS OF INFORMATION PRODUCTION

1. Specifying the costs and benefits of information production

I assume that information producers are rational, well informed about their expected costs and benefits, and when they engage in information production, they do so in order to maximize the difference between their costs (including opportunity cost of engaging in information production) and benefits.[31] I use the common assumption that human capital[32] and existing information are the most important inputs into information production, ignoring capital and labor in the more traditional sense.[33]

The body of information available in a society at a given moment for use as input into new production, *I*, is comprised of information that is either owned or unowned. Owned information is all owned by some*one*, so any piece of owned information is, for some firm (or individual), owned by it, $I_{intrafirm}$. All unowned information is information in the public domain,[34] I_{pd}. For each firm, all owned information that it does not own is

[31] In other words, I do not rely on claims about bounded rationality, or lack of information, or incommensurability between the motives of noncommercial producers and commercial producers. These rather common objections to the standard economic model for intellectual property would likely magnify the effects I outline, but not change its direction.

[32] By human capital I mean creative effort. Romer defines human capital as acquired educational capabilities. This is useful when focusing on industrial or scientific innovation, and may make analysis more easily quantifiable, but the element that human capital "gets at" is creativity, as distinguished from the application of work, money, or existing information to a productive enterprise.

[33] Romer, at S74; Arrow, at 618 (two most important inputs are creative talent and existing information).

[34] Throughout this paper I use a slightly unorthodox definition of the public domain, as the range of information uses privileged to all absent particularized facts that prohibit a particular use by a particular

available only through transactions—either by purchase at market price (I_m) or through sharing or barter (I_b). So the universe of available information inputs is seen by each firm as composed of $I = I_{pd} + [I_{intrafirm} + I_m + I_b]$. It is obvious that at any given moment the availability of information from the public domain and the availability of information that is owned by someone are inversely related. Furthermore, the larger a firm's information endowment the less it must either purchase or barter for information from the universe of owned information.

The costs of information production C are the sum of the costs of human capital C_h and of the cost of information inputs C_i. Intellectual property rights effect C by effecting the value of C_i. To the extent that the ratio between C_i and C_h is very low, changes in property rights will have a relatively low effect on the value of C, and hence would have a limited effect on production costs.[35] But even poets borrow from the works of other poets, and I assume that most activity would fall within Kuhn's concept of "normal science," and that for such incremental information production the ratio between C_i and C_h is high enough such that the effects of intellectual property on the magnitude of C_i are large enough to affect C. For purposes of this paper I assume that the ratio between the quantity of information inputs and the quantity of human capital used in producing a given information product is exogenous (say, determined by the nature of the

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person. For a defense of this definition as more useful than the doctrinal definition for analyzing social consequences of changes in intellectual property law see Yochai Benkler, Free As the Air to Common Use: First Amendment Constraints on Enclosure of the Public Domain 74 N.Y.U. L. Rev. 354 (1999). The validity of the analysis in this paper in no way depends on whether one adopts my definition or the more conventional definition.

[35] One might imagine activities that require more or less creativity, while nonetheless being creative enough to justify protection. Say, the difference between writing a sonnet and writing a news report about a specific event. To the extent, in other words, that a productive activity has a very high C_h value, the implications of the analysis that follows are attenuated.

information product and the way in which the discipline of producing this type of information mixes information inputs with creative talent).[36]

C_i is comprised of the cost of information inputs available at a positive, above-marginal-cost "market" price[37] (I_m available at C_m), those available at marginal cost from nonmarket sources, ($I_{\not m}$ (=I_{pd} + $I_{intrafirm}$) at $C_{\not m}$ (= 0)) and those available from other firms that barter or share their information (I_b at C_b),[38] and the cost of communicating information inputs from those who have them to those who do not (C_{comm}).[39]

$C_i = C_{\not m} + C_m + C_b + C_{comm}$. A firm will seek to minimize its costs by using, to the extent possible, inputs available at $C_{\not m}$. In order to explain why any owned information inputs would be purchased at C_m while there existed inputs from nonmarket sources, I assume that there is some heterogeneity in the suitability of inputs to producing a given new product, given available human capital. In order not to bias the analysis in favor of one type of input or another, I further assume that any given existing input has a probability of being the best input to be combined with available human capital to produce a product, and that this probability is independent of that input's being owned or unowned, or

[36] Obviously, however, one response to increases in C_i is to lower the ratio of the quantities of information inputs to human capital by using more creative talent, although then presumably the price of human capital would rise, increasing C in an indirect, rather than direct, response to the increase in C_i.

[37] The market price must be at least the reservation price of suppliers, which must cover production costs and must therefore be a positive price. The marginal cost, as explained earlier, of information, is zero, reflecting that information is a nonrival good—once produced, no social resources need be expended to make it available for use by additional users.

[38] The value of C_b will likely be higher than that of $C_{\not m}$, however, because firms will likely "insure" against defection by firms with which they cooperate and share information. They could do this by, for example, investing in defining and protecting intellectual property rights in their own information products, not because they plan to sell them, but in order to have a credible threat of retaliation when the other party defects, or they might design their products with redundancy, in order to avoid over-dependence on a single cooperative player. The cost of this insurance will presumably be less than the difference between C_b and C_m, otherwise the firm would buy a license rather than rely on cooperation. Use of shared information inputs will nonetheless be more expensive than use of a firm's owned inputs or inputs from the public domain.

[39] Note that, unlike the information inputs themselves, the communication of information is a rival good—trees for pulp, copper for wires, and attention for reading are all resources for which there are rival uses.

owned by the firm making the decision or another firm.[40] I assume that the firm knows the probability that that input will be the right input, and that its probability assessment is what causes a firm to value a given input highly enough to pay a positive price for it given the availability of other inputs from nonmarket sources.[41] I also assume that the cost of communicating the information is independent of whether the information is sold or given away for free.[42] Note that if communication costs are very high, the consequences of my analysis are muted just as they would be if human capital costs are disproportionately high. Inversely, as communication costs decline, the relative weight of the costs imposed by the owners of information inputs increases, and with it the effect of property rights on information input costs.

It should now be fairly intuitive to see how increases in the scope and content of intellectual property increase the cost of information production. A change in law that increases property rights, say, an extension of the term of copyright protection so that information that would have been in the public domain continues to be owned for another

[40] A criticism of this assumption is that "commercial" users will likely require more access to commercially produced information, and noncommercial producers are likely to exchange information within the group of similarly motivated producers. If this were true, the implications of the heterogeneity in information production strategies would be much diminished. While this is essentially an empirical question, I think it plausible to assume that, for example, a political satirist needs access to popular iconography, including trademarked icons, whether she sells the rights to put her cartoons on mugs or publishes for free in a nonprofit political medium. Similarly, a person who writes a spreadsheet for Linux needs to provide backward compatibility and user-interchangeability with the dominant spreadsheet program no less than does a commercial company writing a new spreadsheet and trying to enter a market dominated by another spreadsheet. See Lotus v. Borland 49 F.3d 807 (1995).

[41] This does not mean that the firm will always choose the "best" input. It only means that a firm will be willing to pay a positive price for an owned input if it expects to be able to use that input to produce a product whose value is greater, by more than the cost of the owned input, than that of the best product it could produce using any unowned input available to it at zero cost. Since I assume that the firm seeks to maximize net benefits, *supra*, text accompanying note 31, it will choose the input that maximizes its net gains given its cost relative to its estimated utility as input.

[42] If, as is more likely, the cost of communicating information while retaining its excludability is higher than the cost of communicating it without similarly assuring its downstream excludability, then one must treat C_{comm} as an incremental component of each of C_m and $C_{\not m}$, which is as larger for C_m than for $C_{\not m}$. This would simply increase the cost differential between $C_{\not m}$ and C_m, and therefore amplify the effect of an increase of property rights protection on information input costs.

twenty years,[43] decreases the quantity of inputs I_{pd} available at $C_{\sout{m}}$. Inputs that, but for the change in law, would have been available at $C_{\sout{m}}$, will now be available only at the higher C_m or C_b, unless the firm happens to own them. Unless the firm owns the inputs enclosed by the change in law, then, it will see a rise in C_i.

Benefits of information production B_i can be directly appropriated or indirectly appropriated. By "direct" appropriation B_d I mean sale of the producer's agreement to abstain from excluding the buyer from the firm's information outputs.[44] A firm relying solely on direct appropriation would sell access to its information products at least at a price sufficient to cover its production costs, including compensating for failed attempts—its optimal supply price—or at a premium above that price if it has any market power because of a lack of substitutability for its information goods.

"Indirect" appropriation $B_{\sout{d}}$ refers to the residual category—any means by which the producer can obtain a benefit from producing the information other than sale of permission to access it.[45] Indirect appropriation can be attained from both market and nonmarket sources. It could be attained by correlative gains in the sale of another product or service whose sales increase as a result of the information production. These gains could be supply-side effects in the correlated market, where the producer itself gains advantage through early access to the information—as in the case of industrial

[43] In this paper I do not attempt to differentiate between specific different rules, which may have different effects on various strategies. An obvious next step in the analysis, which I leave for another paper, will be to examine specific rules to see how their effects are likely to deviate from the effects of a generic, analytically defined "increase in protection", which refers to an across the board increase in legal excludability of information outputs—like a generally-applicable term extension.

[44] This definition is backed out of the technologically/legally-determined element of what makes something an economic good—"excludability." It is the appropriate definition because the economic function of property rights is to enhance excludability, and the definition therefore separates for analysis those firms that utilize the excludability created by property rights from those that do not.

[45] Because information is nonrival and its optimal demand price at any moment is zero, the extent to which producers can employ indirect appropriation mechanisms is precisely the extent to which dynamic production incentives can be attained without the usual sacrifice of static allocation efficiency.

R&D where first mover advantages can permit a firm to convert early access to information into a production and sales advantage; or they could be demand side effects, because access to the information by others leads to increased demand for the other product or service offered by the information producer. Indirect appropriation could also rely on nonmarket institutions, like grant funding. At the individual creator level we might see educational gains and reputation gains, and we might also think of creative individuals as having a measure of taste for creation, so that at least some benefit is hedonic. Any academic who could command higher personal income in practice than in an academic setting has made a personal choice to prefer some combination of education, reputation, and hedonic gains in exchange for reduced direct payment for that person's ability to produce information.

Information production will be sustainable throughout the ranges in which $B_i > C$, or $B_d + B_{\not d} > C_h + C_m + C_{\not m}\ (I_{pd} + I_{intrafirm}) + C_b + C_{comm}$. In other words, the sum of direct and indirect benefits must exceed the costs of human capital, the costs of information inputs: owned by others and available at market price, owned by the producer or unowned (in the public domain) and available at marginal cost, or owned by another firm and obtained through sharing or barter, and the costs of communicating these information inputs to the firm that intends to use them.

Table 1: Notations

I – information
I_{pd} – information in the public domain
$I_{intrafirm}$ – information owned by the firm making a production decision
I_m – owned information available from the market
I_b -- owned information available in barter
C – costs of information production
C_h – human capital costs
C_i – information input costs
C_m – cost of information available from markets
$C_{\not m}$ – cost of information available from public domain or intrafirm sources
C_b – cost of information available in barter
C_{comm} – cost of communicating information
B_i – benefits of information production
B_d – benefits acquired by direct appropriation
$B_{\not d}$ – benefits acquired by indirect appropriation

2. Effect of property rights on costs and benefits

If no property rights were recognized, direct appropriation would be impossible, and the condition for information production would be $B_d > C_h + C_m (I_{pd}) + C_{comm}$. In other words, in the absence of property rights some combination of indirect gains must cover the cost of human capital and of communicating information from those who have it to those who do not. This is hardly an earth-shattering revelation, but it does underscore that in an industry where the marginal cost of one major input is zero, and the other major input involves individual creativity, low-cost, low-returns strategies are a significant plausible production strategy. This is the essence of the claim that people develop Linux for "egoboo,"[46] and is also consistent with the modest information production achievements that followed the invention of print—which drastically reduced communication costs by permitting many copies to travel to readers, instead of readers to travel to single manuscripts—but preceded the invention of intellectual property rights, like the Copernican Revolution.[47]

The introduction of property rights is what introduces B_d, I_m at C_m, $I_{intrafirm}$ at C_m, and I_b at C_b, into the equation. This is done by limiting availability of inputs of the I_{pd} variety. Again, it is easy to see that, as the standard model predicts, increasing intellectual property rights will make sense only so long as the increases permit a greater increase in B_d than in the sum of C_m, $C_m (I_{pd} + I_{intrafirm})$, and C_b. As the public domain shrinks, a greater proportion of inputs must be purchased at C_m, unless the firm has a large inventory of existing information and can increase utilization of $I_{intrafirm}$ at C_m rather

[46] Raymond, Cathedral and Bazaar, *supra*.

[47] Elisabeth Eisenstein describes the centrality of print to the revolution in astronomy in the late 15th, early 16th century precisely in terms of the reduction in the communication cost of obtaining the works of past astronomers in The Printing Press as an Agent of Change 578-82 (1977).

than I_m at C_m. Furthermore, to the extent that the likelihood that any given information input will be useful today is independent of how it was produced yesterday (i.e., out of public domain or owned inputs; by a producer that relies primarily on direct or indirect benefits), an increase in property rights increases the expected price of information production for all producers. Producers that before the change relied on obtaining only indirect benefits from production must face higher expected costs, while gaining no benefit, because an increase in protection increases only B_d, not $B_{\not d}$.

Another implication is that information inventories are likely to exhibit scope economies in the face of an increase in property rights, because a larger inventory represents more varied inputs available at marginal cost for a given pool of human resources. The larger and more diverse an inventory, the higher the probability that an input necessary to produce a new piece of information will be in it. (Assuming that the probability that an information input will be the best input for a new product given available human capital is independent of whether that information input is owned or unowned, or owned by the firm facing the decision about which input to use or another firm.) Two organizations that combine their creative workforces and give each member of the combined workforce access to the joint inventory are likely to have better suited information inputs available at marginal cost to use in a given project than the same two organizations when each workforce utilizes only its organization's independently-owned inventory.[48] This effect is cumulative to the more obvious benefit of integration, that it avoids transaction costs associated with purchase of information inputs owned by others.

[48] This is an extension of Romer's point that information production in an economy is an increasing returns activity. See Romer, *supra*, at S94-S95.

Its importance increases as the public domain shrinks and intrafirm sources become increasingly important sources of information inputs at marginal cost.

The detailed specification of what goes into the costs and benefits of information production suggests, then, that there is a systematic conflict between the interests of organizations that appropriate the benefits of information production indirectly and those that appropriate benefits directly. The former group maximizes the delta between B_d and C_i when the value of C_i is low, and gains nothing from increases in intellectual property rights. The latter group maximizes the delta between B_d and C_i by increasing B_d for so long as the increase in B_d is greater than the correlative increase C_i.

Take the following arithmetic example. Imagine that the law changes from a rule that permits researchers to make personal-use photocopies of single articles from journals to which the organization in which they are employed subscribes, to one that requires them to pay royalties for each photocopy.[49] Assume that photocopying without a royalty is free and that the royalty is transferred with no loss to transaction costs (these assumptions mildly simplify, but do not change the analysis). Imagine that every journal subscription costs $100 and each journal has 10 articles; the photocopying royalty is $1 per article copied; and an efficient researcher needs repeated immediate access (of the type obtained from having your own copy) to 10 prior articles in order to produce a new article. An organizational librarian has a $10,000 budget to serve 100 researchers. Before the change in law, the librarian subscribes to 100 different journals and photocopies the 10 articles needed by researchers for each new work they produce (I assume that the original journal must be kept available for others to read other articles in it). Each

[49] This is a modification of the facts of American Geophysical Union v. Texaco, 60 F.3d 913 (2nd Cir. 1994) (holding that commercial companies must pay royalties for copies made by their researchers).

researcher had 1000 different articles from which to choose as his or her 10 repeat-access articles for a new article. After the change in law, if the organization owns none of the journals, the cost for each production cycle of one new article per researcher in the organization would be 10 (articles)× $1 (royalty) × 100 (researchers)=1000. The library could adopt any combination of three basic solutions to cover the new cost: (1) buying 90 journals for $9000, reserving $1000 for photocopying, and reducing the number of articles available as inputs for researchers to 900; (2) buying 100 journals, but providing researchers with no photocopies of articles, so they have degraded access to the same amount of inputs and must queue for repeated access, delaying production and perhaps degrading quality because of unwillingness to wait; and (3) increasing the budget by $1000.

If, say, the library serves a nonprofit research institute that circulates its products as a working paper series at print and postage (communication) cost, increased protection entails no increased returns. Unless it can increase its budget from unrelated sources, the library must either decrease quality of access to the same information inputs (by time delay through making fewer personal copies available) or decrease the quantity of information inputs available to its clients at the same quality (by making the same number of personal copies available, but holding fewer journals).

A commercial journal that provides commentary written by its staff will experience similar increases in input costs to its staff for access to other publications. Imagine the same size human capital pool and information input needs, and the same budget of $10,000 generated from sale of 100 copies of its journal at $100 each. Its new photocopying cost will be $1000. The journal is indifferent to the new rule if on average

each of the 10 articles in each issue is photocopied by 100 researchers who are not part of the organization, so that photocopying royalty payments completely cover the increased cost of inputs. If it expects more unaffiliated researchers to need personal-use copies of its articles, then it sees a net gain from the change in law.

Now, imagine that the commercial journal is owned by Elsevier, which publishes over 2,000 journals. Imagine that four of the ten journal articles to which each of its 100 in-house researchers need access are in Elsevier journals, and hence available royalty-free from intrafirm sources. The new photocopying royalty costs for each new article written would be only $6, and for the whole journal $600, compared with the $1000 spent by the independent journal or nonprofit institute. In other words, by being part of a larger organization that owns a lot of the information likely to be useful as input into new production, the journal is more likely to get the benefit of the new right to photocopying royalties without incurring much of its cost. On average, only 60 unaffiliated researchers need photocopy each article in the journal to cover the increased cost.

IV. A MAP OF INFORMATION PRODUCTION STRATEGIES

It is possible to outline a series of ideal-type strategies based on different combinations of the ways in which the benefits of information production can be appropriated and the cost of inputs minimized. Inputs can be obtained below market price from the public domain, from intrafirm sources, or through sharing/barter with others. Benefits can be appropriated directly or indirectly. Indirect appropriation strategies can be divided between those that rely on market returns affected indirectly by the information production and those that rely on appropriation through nonmarket

mechanisms. Table 2 maps nine ideal type strategies characterized by these components. The text describes them in more detail. All these strategies can seek information inputs from the market at market price, as well as from the public domain at marginal cost. I do not assume that they use solely their identifying source of inputs. Furthermore, the strategies are ideal types. Any organization can use a mix of them.

Cost minimization / Benefit maximization	**Public domain**	**Intra-firm**	**Barter/sharing**
Direct	**Romantic maximizers**	**Mickey**	**RCA** (patent-based sales w/ cross-licensing and patent pools)
Indirect **Market**	**Scholarly Lawyers** (lawyers /doctors who write in journals to attract clients)	**Know-how** (law firm corporate forms; industrial know-how)	**Learning networks** (informal sharing; defensive patent portfolios
Nonmarket	**Joe Einstein** (amateurs; academics; census bureau)	**Los-Alamos**	**Being There** (circulating drafts, workshops)

Table 2: Ideal-type information production strategies

I begin with the strategy assumed by the traditional economic model to be the usual appropriation strategy. Appropriation is achieved by selling permission to use the information these organizations produce, or from above-normal profits attained by excluding competition *through assertion of rights*.[50] These organizations do not own inventory. They include organizations that sell a single software product or a patented gadget, as well as authors selling publication or movie rights or independent code writers who sell to a larger software company. Because they describe the traditional conception

[50] The focus on rights-based appropriation—through sales or post-innovation legally protected monopolies—is justified because it is the standard model's basic assumption that the drive to obtain such rights-based monopolies is what makes intellectual property work. The alternative assumption, that innovation is driven by market structure that precedes, and is independent of, the assertion of rights in the

of an author laboring in expectation of royalties, I call this strategy "the romantic maximizer." Their sole source of marginal-cost inputs is the public domain.

The second strategy similarly sells information outputs, but minimizes costs by vertically integrating sale and management of an inventory of information products with production of new information. Disney or Time-Warner would be examples. The coarsest version of this strategy might be found if Disney were to produce a "winter sports" 30 minute television program by tying together scenes from existing cartoons, say, one in which Goofey plays hockey followed by a snippet of Donald ice skating, etc. More subtle, and representative of the type of reuse relevant to the analysis here, would be the case where Disney buys the rights to Winnie-the-Pooh, and after producing an animated version of stories from the original books then continues to work with the same characters and relationships to create a new film, say, "Winnie-the-Pooh—Frankenpooh" (or Beauty and the Beast—Enchanted Christmas; or The Little Mermaid—Stormy the Wild Seahorse).[51] I call this strategy "Mickey." Its adherents have the advantage over other strategies that they have a higher likelihood of finding usable inputs from intrafirm sources at marginal cost when public domain sources dry up. They likely incur some transaction costs not shared by romantic maximizers—inventory administration cost—which dissuade at least some romantic maximizers from developing towards a Mickey model.[52]

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product of innovation is what marks the divide between the welfare economics analysis of intellectual property and the neo-Schumpeterian tradition of analyzing innovation.

[51] A search under "Disney" of Amazon.com is quite instructive about the range of uses that can be made of this strategy.

[52] In the absence of such a cost, it might be more accurate to see all romantic maximizers as Mickeys-in-the-making. But even in the absence of such costs, one could imagine that some producers specialize in highly innovative production and are bad at inventory management, while others would be better at managing inventory and recombining inventory items with new productive effort.

The third strategy also relies on direct appropriation, but uses barter to reduce input costs. The cross-licensing and market-sharing agreements among the radio patents holders in 1920-21 are a perfect example.[53] RCA, GE, and AT&T held blocking patents that prevented each other and Westinghouse from manufacturing the best radios possible given technology at that time. The three companies entered an agreement to combine their patents and divide the radio equipment and services markets in 1920. Westinghouse joined the pool in 1921, adding its own patents, which increased the effectiveness of home receivers. Throughout the 1920s this group pursued direct appropriation by using enforcement actions to exclude competitors from the radio equipment markets, seeking precisely the post-innovation monopoly rents sought to be created by patents.

The remaining strategies all rely on indirect appropriation of benefits. This does not mean that most or any of them have no property rights in their information products. It simply means that their production strategy does not depend on assertion of rights, and that they will often forgo the expense of enforcing rights without affecting their basic sustainability.

The fourth strategy relies on a positive correlation between availability to others of the information an organization produces and *demand* for other products it produces. Doctors or lawyers who publish in trade journals are an instance of this strategy. Hence, "the studious lawyer." This is the model of appropriation heralded a few years ago by Esther Dyson[54] and John Perry Barlow[55] as the future of content production in the digitally networked environment. Another instance are companies that make their

[53] See Gleason L. Archer, History of Radio to 1926 172-198 (1938); Erik Barnouw, A Tower in Babel: A History of Broadcasting in the United States, Vol. 1, 59, 65, 72-73 (1966).
[54] Esther Dyson, Intellectual Value, WIRED 3.07 (1995).
[55] John Perry Barlow, The Economy of Ideas, WIRED 2.03 (1993).

information widely available so as to produce a product-ecology conducive to the success of another product.[56] Xerox's development of the Ethernet standard for LANs, which increased the value of sophisticated network printers and copiers is an example. These organizations do not sell their outputs, but produce them for free distribution so as to maximize their effect on the correlated market.

The fifth and sixth strategies are two aspects of supply-side effects of information production, and seem to be common strategies for industrial R&D outside of drug companies.[57] Like scholarly lawyers, these organizations rely on indirect appropriation from market sources based on a positive correlation with their own information production, but the positive effect relies on the supply-side advantages they gain from their own access to the information, rather than on the demand side effects of its wide dissemination. These could be firm-specific advantages, like production know-how, which permit the firm to produce more efficiently than competitors and sell better or cheaper competing products.[58] The information produced is available at marginal cost for intrafirm use, and its benefits are appropriated using indirect market effects. I call this strategy "know-how" to note Arrow's suggestion that a good deal of information is produced by this mechanism.[59] Lawyers might be more familiar with the advantages a

[56] An accessible statement of the dynamics that drive this strategy is W. Brian Arthur, Increasing Returns and the New World of Business, Harv. Bus. Rev. Jul/Aug 1996, 100.
[57] See Levin *et. al.*; Mansfield *et. al.*
[58] Levin et. al., *supra*, at 794-96 (secrecy, lead time, and learning curve advantages regarded as more effective than patents by most firms). See also F.M. Scherer, Learning by Doing and International Trade in Semiconductors, (faculty research working paper series R94-13, John F. Kennedy School of Government, Harvard University 1994) (empirical study of semiconductor industry suggesting that for industries with steep learning curves investment in information production is driven by advantages of being first down the learning curve rather than the expectation of legal rights of exclusion).
[59] Kenneth J. Arrow, The Economic Implications of Learning by Doing, 29 Rev. of Economic Studies 155-73 (1962).

law firm obtains from having well developed forms to speed up and maintain the quality of common tasks.

Like the know-how strategy, the sixth strategy relies on indirect supply-side market-based benefits of information production. The distinguishing feature of this strategy is that it minimizes costs by sharing information with similar organizations to capture economies of scale, or with organizations in different industries similarly invested in information production, to capture economies of scope.[60] Like know-how organizations, and unlike Mickeys, RCAs or romantic maximizers, these organizations do not directly sell information or assert rights to exclude competitors. They use early access to the information, gained by their investment in information production, to collect above-normal profits available to those who have early access to the information. This can be done by increasing production efficiency relative to competitors while keeping the information secret, or by participating in an oligopolistic pool, entry into which is reserved for those who have sufficient information production capacity to "pay" for participation. Participants might barter their information for access, or simply be part of a small group of organizations with enough knowledge to exploit the information generated and informally shared by all participants in this "learning network".[61] Rents are obtained from the concentrated market structure, not from assertion of property rights,[62] which is what distinguishes this strategy from the RCA strategy. While these organizations will not sell patents or assert them to appropriate the benefits, they

[60] Richard R. Nelson, The Simple Economics of Basic Scientific Research, 48 Journal of Political Economy 297-306, 303 (June 1959); Walter W. Powell, Networks of Learning in Biotechnology, Opportunities and Constraints Associated with Relational Contracting in a Knowledge-Intensive Field (June 25-27, 1998) (presented at Intellectual Products: Novel Claims to Protection and Their Boundaries (La Pietra, Italy)).
[61] The behavior is described in Wesley M. Cohen and Daniel A. Leventhal, Innovation and Learning: The Two Faces of R&D, 99 The Economic J. 569-596 (1989). The term I borrow from Powell, *supra.*

nonetheless must engage in defensive patent portfolio development so that they have chips to bargain with and to defend against defection by other participants who later try to use patents to control information originally shared.[63] While this strategy is usually described in the patent context, it is not limited to industrial R&D. Newspapers that use cooperative news agencies and rely on timeliness and accuracy of reporting rather than long-term control of copyrights are also an example of this strategy.

The remaining strategies describe a series of producers who rely on nonmarket institutions to obtain the benefits of their production, necessarily indirectly. The seventh strategy lumps together what is in fact a diverse category of nonmarket actors. They include universities and other research institutes; government research labs that publicize their work or the Census Bureau; individual academics; authors and artists playing to "immortality"; as well as a host of amateur endeavors, ranging from contributors to the op-ed page, to amateur choirs, to participants in a mailing list or a web-based discussion forum. I call this strategy "Joe Einstein." This is the strategy used to produce most basic science and political argument (political parties and civic advocacy groups are Joe Einstein organizations), among other important information goods. Joe Einsteins minimize input costs by obtaining information inputs from the public domain. They make information outputs freely available, either by placing them in the public domain—most obviously when publishing patentable innovations without seeking a patent—or by refraining from enforcing proprietary claims, or by specifically and publicly licensing all to use and transform their materials—as with the case of open source publication under

[62] See, *e.g.*, F.M. Scherer, Nordhaus's Theory of Optimal Patent Life: A Geometric Reinterpretation, 62 Am. Econ. Rev. 422-427 (1972).

the General Public License. They appropriate the benefits of their investment, if at all, through reputational gains, research grants, charitable contributions, teaching positions rationed by publication-based reputation, or from desired behavioral adaptations by their audiences (political and religious organizations are the obvious instance of the latter). Amateurs cross-subsidize their information production with revenues unrelated to the information production function they fulfill. Some production in this model may occur with no expectation of appropriation, as a reflection of the producer's taste for creativity.

The eighth and ninth strategies describe either temporary or partial departures of "Joe Einstein" organizations from the output-management strategy of publicizing the information and making it available in the public domain. The strategy I call "Los Alamos," as suggested by its name, refers to nonmarket organizations that rely heavily on their own information products as inputs into their own production, and do not make that information widely available because their nonmarket function requires that the information *not* be disseminated. In other words, production is financed by nonmarket sources that are interested in acquiring the information but limiting access to it. The strategy I call "Being There" is more temporary, and relates to the time delay some nonmarket producers can use to gain relative advantage later on, when they switch to the Joe Einstein strategy. Releasing a draft paper to a limited set of colleagues to get comments and improve it before publication would be an obvious example.[64] This activity, carried on over time, parallels in the nonmarket arena the information sharing pools whose participants share information to gain advantages in their correlated markets.

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[63] On the correlation between increased scope and availability of patents and defensive acquisition of patents see Bronwyn H. Hall and Rose Marie Ham, The Patent Paradox Revisited: Determinants of Patenting in the US Semiconductor Industry 1980-1994, NBER Working Paper 7062 (March 1999).

V. EFFECTS OF CHANGES IN INTELLECTUAL PROPERTY RULES

An "increase in intellectual property rights" means a change in law that increases the excludability of information products.[65] While nonrivalness of information is a purely technological fact, and cannot be affected by changes in institutional background, excludability is a combined product of the technology available for exclusion and legal rights to exclude. Intellectual property affects production incentives, if it at all, by changing the legal parameters of the measure of excludability of information products. A change in the prevailing intellectual property law can be said to "increase" or "decrease" protection based on whether it is likely to increase or decrease excludability of information products. Information is "in the public domain" to the extent that no one may rely on legal rights to exclude anyone else from its use.

By definition, the only strategies that can benefit from an increase in intellectual property protection are the three "direct" appropriation strategies, for only they rely on legally-based exclusion to appropriate the benefits of their production. The various indirect appropriation strategies do not benefit, because they either release the information for public domain use or keep it under lock-and-key (know-how or Los Alamos). Learning network participants are the only potential beneficiaries in this group, because they at least sometimes rely on intellectual property. But their use is defensive, as bartering chips or to threaten retaliation against defection. An increase in excludability will likely present no more than an upward shift in the respective withholding power of all the cooperating organizations, perhaps with some internal adjustments based on how

[64] Marshall Van Alstyne pointed out to me that such early release to the relevant community of knowledge also "marks" a statement as belonging to the maker of it. This secures for that person the credit of making the statement, which is the central component of academic appropriation of the benefits of production.

the change in law affects different types of information different participants produce, but without systematically benefiting the category as a whole.

Strategies that rely on the public domain as their primary source of marginal cost inputs will suffer the greatest cost increase. This would include, unsurprisingly, Joe Einsteins, but also scholarly lawyers and romantic maximizers. The last of this group—romantic maximizers—are a counterintuitive result, because small-scale independent producers of information products are usually thought to be the primary beneficiaries of legal protection. Organizations that minimize costs by utilizing intrafirm sources of information suffer less of an increase in costs, because access to their owned inventory continues to be at marginal cost. Organizations that rely on barter or sharing may be forced to engage in more aggressive rights acquisition because an increase in excludability increases the probability that their utilization of a collaborator's information could provide grounds for a strategic suit. While this increases the cost of using barter and sharing systems, the increase in protection is a wash in terms of its barter value because all these organizations are affected along parallel lines.

Only the three direct appropriation strategies stand to gain anything from an increase in property rights protection. Of these three, romantic maximizers, the quintessential "authors" whose claims endow intellectual property law with its most attractive normative justification, suffer the greatest cost increase. While all direct appropriators gain the upside of an increase, romantic maximizers suffer more of the downside because they have no inventory to fall back on when the public domain is diminished for either inputs or bargaining chips. This does not mean that increases in

[65] I specifically limit my analysis here to the effects of this broad analytically-defined term, and leave for future work analyzing how specific actual rules might benefit one strategy or another in ways that deviate

protection are bad for romantic maximizers. They are, initially at least, a necessary condition for their existence; and as the standard model suggests, increases will continue to benefit them so long as the increase in costs is outweighed by the increase in ability to appropriate the value of their production. But as among the strategies that benefit from increases in rights, romantic maximizers are more likely to suffer net losses from an increase in rights than either Mickeys or RCAs, and are therefore likely to suffer the counterproductive effects of intellectual property rights predicted by the standard model sooner than either of the other direct appropriation strategies. The biggest winners are Mickeys. Not only do they gain the benefits of the increase and mitigate their costs by reutilizing inventory, they also gain a distributive windfall on inventory they own at the time of the change in law. A twenty-year extension in the duration of copyright gives Disney twenty more years of selling The Mouse after production costs have already been sunk. These expected benefits—probability of cheaper future production and windfall on existing inventories—should also make more attractive, *ex ante*, incurring the transaction costs that Mickeys must incur to accumulate and maintain their distinguishing characteristic—their inventory.

Standard assumptions about what people and organizations do when the net costs of one activity and the net benefits of another increase would lead us to expect a decline of activity by those who use indirect appropriation-based strategies and an increase in the activity of those using direct appropriation. We would expect to see creative individuals—human capital—and information inputs being reorganized to respond to the relative costs and benefits associated with the new level of property rights protection. More of these factors of information production will likely be employed using direct

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from the general effect I identify in this paper.

appropriation strategies, and fewer would be used to produce for indirect appropriation, in particular using studious lawyer and Joe Einstein strategies. Individuals who previously worked using these strategies could be hired by romantic maximizers, RCAs, and most likely, Mickeys. As among the direct appropriation strategies, the greatest net benefits accrue to Mickeys. They are therefore likely to expand more rapidly than the other direct appropriation strategies in their utilization of the freed factors, as well as factors from outside the information production universe that can be paid a better return than was available to attract them before the change in law. Given that more of the universe of information production factors will be organized using direct appropriation strategies, and in particular Mickey, and assuming no radical change in the productivity of individuals who work in the different strategies relative to their productivity prior to the change, more of the universe of new information produced after the change will be produced by Mickeys. We would also expect to see some romantic maximizers being bought or hired by the higher-return Mickey organizations, and a consolidation of Mickey organizations in order to gain the economies of scope created by internalizing large and diverse inventories of information inputs and human capital pools.[66]

It is important to underscore that the behavioral adaptations outlined arise from the decline in availability of information for use at marginal cost in new production, not primarily as a response to an increase in transaction costs that accompanies the expansion of rights. Even if information were licensed through a mechanism that eliminated transaction costs altogether, it would still be licensed at a price above marginal cost, because suppliers that license their information products must see a positive price in order to supply their products. Any organization that previously obtained information

[66] See *supra* text accompanying note 48.

inputs from the public domain at marginal cost will see an increase in cost if those inputs become subject to licensing. Similarly, any organization choosing between an information input available from its owned inventory and an information input that must be licensed will see a price equal to marginal cost for inputs from its own inventory, and an above-marginal cost price for external inputs. The presence or absence of sophisticated licensing mechanisms, whether technological or through collective rights organizations,[67] will affect the magnitude, but not direction, of the effects of increases in intellectual property on the payoffs to the strategies described here. These effects persist even in an environment perfectly regulated by the most efficient organizationally or technologically facilitated contracts.

VI. FEEDBACK EFFECTS

Organizational adaptations to an expansion of intellectual property protection will likely have feedback effects that amplify the direction and speed of the shift in strategies, and lock them in institutionally. First, a larger ratio of new information will be owned, further decreasing the availability of pertinent public domain materials. Second, more investments will be made in effecting additional institutional changes that make ownership of inventory and integration of new production with inventory management more profitable. Third, more investments will be made in producing demand for information of the type produced for sale and by reuse of owned inventories. And fourth,

[67] Rob Merges is the primary proponent of the position that effects on transaction cost-reducing mechanisms like CROs can justify stronger property rights in information than the traditional model would normally prescribe. See See Robert P. Merges, Contracting into Liability Rules: Intellectual Property Rights and Collective Rights Organizations, 84 Cal. L. Rev.1293 (1996); Robert P. Merges, Intellectual Property and the Costs of Commercial Exchange, A Review Essay, 93 Mich. L. Rev. 1570 (1995).

organizations that expect these developments will shift to strategies that fare better under increasing protection conditions.

1. Increased cost of newly minted information inputs

It is likely that newly minted information is not perfectly substitutable for old information. This will be particularly pronounced in sectors dependent on incremental progress, as in software development, as well as in fashion-sensitive products where taste changes rapidly. Access to fresh information is therefore likely to be an independent subcategory within the mix of information inputs an organization needs to engage in new production. An increase in the proportion of new information that is produced by Mickeys and romantic maximizers, who produce enclosed information, and a decrease in the proportion of information produced by Joe Einsteins or studious lawyers, who produce unenclosed information, will cause a larger portion of the subcategory of *new* information produced after an expansion of property rights to be owned. This increase in the proportion of owned information increases the probability that, after the change, information that producers need as input will be enclosed, rather than in the public domain. This effect mimics and amplifies the effects of the initial increase in intellectual property protection. The analysis follows.

An organization seeking information inputs will see the world as composed of two lots of information inputs, old information I^o and new information, I^n. To represent this, assume that the organization needs to pick one input out of each lot. Assume that each of I^o and I^n is comprised, like I, of I_{pd} + [$I_{intrafirm}$ + I_m + I_b]. At T_0, I^o and I^n are comprised of identical ratios of I_{pd} to [$I_{intrafirm}$ + I_m + I_b], say 1:1. To simplify, ignore I_b and assume that of all owned information, an organization with a large inventory sees

10% as $I_{intrafirm}$ and 90% as I_m, while a small organization sees 100% as I_m. We can see the effects in a simple arithmetic example, by assuming that the cost of a new input from I_{pd} or $I_{intrafirm}$ is 0 and the cost of a new input from I_m is 1. At T_0 the expected cost of inputs for a small organization is $[(0.5\times0) + (0.5\times1)] \times 2 = 1$, representing the equal probability that an input will be available at a cost of 0 from the public domain or at a cost of 1 from market sources, which is equal as to each lot from which the producer must pull an input. For an organization with a large inventory, the expected cost is $[(0.5\times0) + (0.05\times0) + 0.45\times1] \times 2 = 0.9$. In other words, for such an organization there is a small probability that an owned input will be available from its own inventory at 0, rather than from market sources at 1, and this is equally so for both lots.

At T_1 a new law is passed, that increases intellectual property protection. Part V suggests that at the margin slightly less information produced after T_1 will be produced by Joe Einsteins or studious lawyers, and slightly more will be produced by romantic maximizers, RCAs, and Mickeys. The latter organizations all produce information that is owned, and hence is one of $I_{intrafirm}$, I_m, or I_b. The former organizations produce information that is all part of I_{pd}. We would represent this shift by suggesting that at a later time, T_2, a producer facing the universe of information inputs will continue to see a ratio of 1:1 for I^o_{pd} relative to $I^o_{intrafirm}$, I^o_m, and I^o_b,[68] but will see another ratio, say, 1:1.5, of I^n_{pd} relative to $I^n_{intrafirm}$, I^n_m, and I^n_b. Again, we can ignore I_b, and we can see that an organization with no inventory will see an expected input cost of

[68] The assumption does not fit any case of retroactive application, which is the normal case when the increase in protection is achieved by judicial interpretation, and is often the case in legislation, because legislation often responds to the pressures of those who already own inventories and are seeking the windfall created by retroactive legislation. The assumption is necessary in order to isolate the feedback effect, independent of and cumulative to the direct effect of the increase in protection, which is what would change the ratios of owned to unowned old information. But relaxing the assumption would simply magnify the effect by combining direct and feedback effects into a single analysis.

$[(0.5\times0) + (0.5\times1)] + [(0.4\times0) + (0.6\times1)] = 1.1$. Since it must pick one input from the new information lot, and since the expected price of inputs from that lot has increased, the producer will see an increase in expected costs. It is important to note that this increase is cumulative to the increase that caused the initial change in payoffs, and is not caused by an additional increase in legal protection. It is the adaptation of organizations to the initial legal change by adopting more direct-appropriation based strategies and decreasing production for the public domain that increases the expected cost of new inputs, and hence the expected cost of information production generally. As with the original effect of the increase in rights, the feedback effect exists, but is muted for organizations with large inventories, because of the probability that inputs will be available from $I_{intrafirm}$:

$[(0.5\times0) + (0.05\times0) + 0.45\times1] + [(0.4\times0) + (0.06\times0) + (0.54\times1)] = 0.99$.

As with the original change in payoffs, the negative feedback effect of an increase in property rights occurs at a slower pace for organizations with large inventories. This would lead one to expect increasing adoption of Mickey strategies as other strategies become unsustainable while Mickey persists.

2. Political economic feedbacks

Given the effects of institutional change on the returns to different organizational strategies, rational organizations will invest in sustaining favorable institutional arrangements. They will attempt to pass new institutional changes that increase the payoffs to their chosen organizational strategy and resist changes that reduce those benefits. Rebecca Eisenberg, for example, describes how after universities were given the right to appropriate government-funded research by the Bayh-Dole Act, they became a new constituency that actively opposed adjustment of the policy when its detrimental

effects became clearer than they were when the Act was passed.[69] Pamela Samuelson describes the battle over the Digital Millenium Copyright Act as one that largely pitted Hollywood, the quintessential Mickey, against Silicon Valley, which appears to rely heavily on know-how, studious lawyer, and Joe Einstein strategies.[70] Increased activity by certain types of organizations will increase investment in attaining institutional arrangements that support the strategy utilized by those organizations. Assuming that lobbying works, this increases the probability that future institutional changes will reinforce the direction of the path chosen in the first institutional choice.[71]

3. Feedback effects on taste

Organizations invest in creating demand for their products. Although the common practice is to treat preferences as exogenous, one need not blind oneself to the revealed behavior of commercial organizations—they invest heavily in producing preferences for their products.[72] After all, one must give Madison Avenue its due.[73] One might imagine, for example, Mickey organizations investing in creating a taste for familiar aspects of their owned inventory, in order to increase the value of reused inventory.[74] Differential

[69] See Rebecca S. Eisenberg, Public Research and Private Development: Patents and Technology Transfer In Government-Sponsored Research, 82 Va. L. Rev. 1663, 1715-24 (1996).
[70] Pamela Samuelson, Intellectual Property and the Digital Economy: Why the Anti-Circumvention Regulations Need To Be Revised, 14 Berkeley J. L. & Tech. 519, 522-23 (1999).
[71] Douglass C. North, Institutions, Institutional Change, and Economic Performance (1990).
[72] A wonderful description of the development of preference-production in the United States as a response to the increase in manufacturing capabilities at the end of the 19th century is James Beniger, the Control Revolution 264-278 (1986).
[73] The 1992 Economic Census indicates that firms spent at least $20 billion a year on preference formation. 1992 Census of Service Industries (taxable firms) - U.S. Summary Business services, SIC 731. Available http://www.census.gov/epcd/www/sc92h73.html.
[74] "An enterprise must consider its ability to capture the potential entrepreneurial benefit resulting from any demand it creates. . . . [A] copyright holder can capture more income by encouraging a desire to watch Mean Streets than from a desire to go for a walk on the mean streets. The Walt Disney Co. benefits more from people enjoying Fantasyland than from their enjoyment in engaging in imaginative fantasies (particularly if their fantasies do not require specific commodified props). . . . A firm gains little from creating preferences unless it is in a position to profit from their existence. Thus, the market incentive is to create preferences for monopolized qualities of products rather than generic aspects of life. And there is no

investment in preference formation creates a positive feedback effect. It increases demand for products of the type produced by organizations utilizing more prevalent strategies and decreases demand for products produced with less commonly utilized strategies. Assuming that all these organizations utilize roughly equivalent strategies to create demand for their information products, with roughly equivalent success, the increased presence of Mickeys and romantic maximizers should lead to increased investment in forming preferences for the products of these strategies. This should increase relative demand for information produced with these strategies, and more for Mickey than for romantic maximizers. Repackaging the Mouse becomes not only cost effective, but also responds to demand.

4. Effects of expectations regarding what other organizations will do

Finally, in dynamic systems rational actors adjust their behavior based on their expectations about the behavior of others, rather than on static conditions at the time of the decision.[75] Organizations will adopt a strategy based on their expectations of the choices of other organizations, and their predictions of the institutional choices to be made through the political process. Expectations that Mickeys will occupy an ever-increasing portion of the information-production environment will likely lead organizations to invest in protectible materials and to shift to Mickey, RCA, or romantic maximizer strategies sooner than might be warranted by a static assessment of market conditions immediately following an increase in property rights. Moreover, expectations regarding the dynamic effects on institutional development will create particularly intense

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incentive to generate desires (or capacities) to engage in activities or to have preferences unrelated to saleable products or services." Baker, Giving the Audience What It Wants, *supra*, at 406-07.

[75] W. Brian Arthur, Beyond Rational Expectations: Indeterminacy in Economic and Financial Markets in The Frontiers of New Institutional Economics 293-94 (John N. Drobak & John V. C. Nye, eds. 1997).

incentives to adopt a Mickey strategy, not only to gain higher returns to new production, but also to obtain transition windfalls from future increases in intellectual property rights.

VII. POLICY IMPLICATIONS

There are two primary policy implications to the analysis offered here. The first involves a series of observations as to why the standard economic analysis of intellectual property overestimates the benefits of intellectual property rights. The second has to do with the normative implications of the observation that decisions about intellectual property law affect the mix of strategies used by information producers.

A. Observations about economic effects of increased property rights

1. The standard model overestimates the benefits of property rights

The standard model focuses on the subset of information producers whose appropriation strategy depends on intellectual property rights. This focus creates a systematic bias in favor of property rights. The traditional approach assumes that all affected producers are equally beneficiaries of increased revenues as they are bearers of increased input costs. It does not account for producers whose costs increase but do not require property rights to appropriate the benefits of production, and therefore are not benefited by increases in these rights. The obvious flaw of this approach is that it looks only at the element of the equation that, on balance, benefits from a proposed change, without looking at the element that, on balance, loses. Since an economy's information production is carried out both by organizations that derive net benefits and by those that bear net losses, a systematic bias to looking at the plus side without the minus side will result in systematic overestimation of the benefits of the policy assessed.

2. Property rights are likely to turn counterproductive sooner than the standard model predicts

The analysis offered in this paper also points out that the adverse effects of property rights in information that are predicted by the standard economic model will occur more rapidly than predicted by that model. These adverse effects may also be difficult to reverse. The standard model predicts that there will be a "theoretical optimal point" for protection, beyond which information input costs become so high that the increased revenue producers gain from selling more perfectly appropriated information will be insufficient to offset them. At that point additional property rights will lead to a decline in productivity. What my analysis of feedbacks adds is a series of amplification effects that are likely to move a property system beyond the theoretical optimal point sooner than would be expected if these effects are ignored. This means that a specific proposed change that would increase aggregate production in a static analysis of the time period immediately following the change in law, will begin a dynamic process whose end point may be beyond the theoretically optimal point. Because amplification occurs through organizational adaptations, and because it entails political entrenchment, the process begun by a change in law consists of a path-determining series of organizational choices that may lock an economy in to this suboptimal arrangement indefinitely.

3. Property rights increase prevalence of organizations that are likely to misallocate human capital to information resources

Finally, the paper suggests that the primary beneficiaries of increased intellectual property rights—Mickey organizations—are likely to misallocate resources for information production. One feature that differentiates the Mickey strategy from other strategies is that it involves the purposeful application of human capital to a set of

information inputs defined by their ownership. Disney employees work with Mickey and Goofy, Warner Bros. employees work with Bugs and Daffy. Mickey organizations are therefore likely to misallocate human capital to work with owned-inventory even if work with information owned by others would be more productive, from a social perspective. This is because they can use their own inventory at marginal cost, while they must pay above marginal cost to, and share some of the social benefit they produce with, the owner of purchased information inputs. This is so even though, from a welfare perspective, the social cost of using either input is equal, and equal to zero.

Imagine that a firm can produce product x with information inputs from its inventory, $I_{intrafirm}$ at marginal cost of zero, plus human capital costs; or product y with information inputs purchased at an above-marginal-cost positive price C_m, plus human capital costs. The social cost of its use of information is zero irrespective whether it uses information from its inventory or from purchased inputs. The firm will produce x rather than y, so long as the price the firm can charge for x, P_x, is greater than the price the firm can charge for product y, P_y, minus the difference between the price of the purchased information input and its social cost, $C_m - 0 = C_m$. For the range $P_x + C_m > P_y > P_x$, Mickey firms acting rationally will misallocate human capital, assuming P_y and P_x similarly represent the social value of the product whose value they capture for the seller. As the cost of market-purchased inputs (C_m) increases because of increases in intellectual property rights (effected by a combination of reduced availability of public domain substitutes and increased opportunities to charge for use), this range will grow, and the misallocation effect will increase in importance.

This discussion does not attempt to provide an empirical basis from which to determine whether specific changes in rules will make an information economy, as a whole, more or less productive. Empirical and sector-specific studies of organizational shifts in response to specific rule changes are necessary to test or implement the proposed framework. The discussion does, however, suggest new qualitative reasons to be skeptical of claims that across-the-board increases in intellectual property rights systematically improve productivity in information production. It is likely that in some sectors, specific rules will increase productivity, but those same rules, applied to other sectors would impede productivity. Negative effects will likely be pronounced where information inputs play a relatively important role in determining the cost of production. Insofar as the pursuit of productivity is concerned, what is required is detailed, sector-specific tailoring of rules, and not general rules that apply to all forms of information production, of all forms of information, by all manner of organization.

B. Normative choices in intellectual property policy

The second category of policy implications of this paper is the recognition of the normative content of decisions about intellectual property rules.

A given level of aggregate production might, in principle, be achievable through different mixes in production strategies. An increase or decrease in intellectual property rights may have no perceptible aggregate effects, while affecting the mix of strategies used for production. Choices regarding the mix of strategies are political. Different people in a society are likely to have different normative commitments about how, aggregate effects aside, information should be produced in a society. One might imagine an argument that having information in society produced by organizations and

individuals responsible solely to market signals is preferable to having information produced by organizations that must rely on government funding or on elitist systems of reputation and prestigious appointments. One might equally imagine an argument that having more of our information environment produced by academics who need not satisfy anyone's taste but their own sense of what is true and good, and amateurs, the yeoman farmers of the information environment, is preferable to having more of that environment produced by Michael Eisner or Ruppert Murdoch.

Consider, for example, the decision to permit federally funded academic research to be appropriated by universities and transferred to the commercial market, rather than left in the public domain or appropriated by the government and freely licensed to commercial developers.[76] It is unclear that such a choice will systematically increase the aggregate value of information produced by a system that has traditionally relied on a mixed strategy of commercial exploitation alongside academic research.[77] But Eisenberg, for one, has suggested that universities have adapted to the new right by tilting their investigative focus towards research that shows a likelihood of commercial

[76] See Eisenberg, Public Research, *supra*, at 1672-1709.

[77] The conventional wisdom is that the academic sector is more likely to produce generally-useful inputs (information inputs with relatively high positive externalities), leaving the commercial sector to focus on incremental perfection of that general knowledge by translating it into product- or firm-specific knowledge that has less significant positive externalities. Richard R. Nelson, The Simple Economics of Basic Scientific Research, 48 Journal of Political Economy 297-306 (June 1959); Arrow, Economic Welfare and the Allocation of Resources for Invention, *supra*, at 623-25; Eisenberg, cDNA sequencing, *supra*; Nelson, What is "Commercial" and What is "Public" about Technology, and What Should Be? in Technology and the Wealth of Nations at 65-70 (Rosenberg, Landau, and Mowery 1992); Ralph Gomory, The Technology-Product Relationship: Early and Late Stages, in Rosenberg, Landau, and Mowery, *supra*, at 388. Empirical evidence has suggested that the rate of industrial productivity increases in a given industry is positively correlated with the amount of basic research carried out in that industry. Mansfield *et al*. Technology Transfer etc., *supra*, at 130. This would explain, for example, Merck's funding of public domain genome research. For a spirited criticism of the notion that market-based research alone will optimize a society's innovation see Paul A. David, From Market Magic to Calypso Science Policy, CEPR Publication No. 485, Stanford University, February 1997.

exploitability.[78] The rule change seems to have caused universities to shift slightly from a model of production that was by design independent of the market to one more responsive to market signals. This effect is consistent with my analysis.

One might speculate that academic authors and presses have, in general, produced different content than authors who sustain themselves through sales by commercial publishers. If expansion of property rights would lead the former to produce more like the latter, then such an expansion of rights raises normative concerns about the overall mix of information available in our society. These normative concerns would be independent of concerns one may have about the quantity produced by all producers in the aggregate, because it would assume that a change in the mix of production strategies and incentives for production would result in a change in the mix of content produced.

My point is not to prefer one strategy to another. The point is that once one recognizes that intellectual property rules affect *how* our society produces information, not only *how much* information our economy produces, choices with respect to intellectual property rules become irreducibly normative, or political. And this normative choice cannot be resolved by reference to economics. This effect is particularly important given the enormous empirical difficulty of predicting the aggregate effects of any given proposed rule change in intellectual property.[79] For, when we have no clear prediction as to the aggregate effects of a rule change, we are, as a matter of practical policy making, in the "all things aggregate being equal" rubric. And at least when we are in that rubric, it is indefensible to frame in positive terms a decision that is by and large

[78] Eisenberg, Public Research, *supra*, at 1714-15.

[79] For a review of recent empirical literature that concluded that no conclusive evidence supports a claim that increased patent protection has increased innovation see Adam B. Jaffe, The U.S. Patent System in Transition: Policy Innovation and the Innovation Process, NBER Working Paper 7280 (August 1999).

normative: a choice of what kinds of people and organizations, responding to what kinds of incentives and operating under what types of constraints, will produce our information environment.