SCIENTIFIC INNOVATION, PHILOSOPHY, AND PUBLIC POLICY

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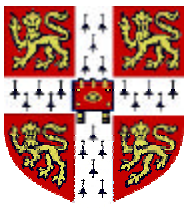

PROPERTY RIGHTS THEORY AND THE COMMONS: THE CASE OF SCIENTIFIC RESEARCH

By ROBERT P. MERGES

I. INTRODUCTION

For some time now, commentators in and out of the scientific community have been expressing concern over the direction of scientific research. Cogent critics have labeled it excessively commercial, out of touch with its "pure," public-spirited roots, and generally too much a creature of its entrepreneurial, self-interested times. In most if not all of this and wringing, the scientific community's growing reliance on intellectual property rights, especially patents, looms large. Indeed, for many the pursuit of patents is emblematic of just what is rotten in the republic of science today.

These concerns with property rights, and commercialization of science in general, spring from a number of motivations. For some, the issue is strictly utilitarian. Under this view of things, the traditional division of labor between the public and private spheres has proven so effective-contributing as it has to the development of such modern indispensables as semiconductors, penicillin, and jet transportation-that to change our approach now is sheer madness.[1] For these observers of the latest trends in science, the changes currently afoot are a threat to kill (or at least cripple) the goose that has laid before us, like so many golden eggs, many of the conveniences we take for granted.

Others are concerned for different reasons. They express a more fundamental objection: that commercializing the heretofore noble, pure, and otherwise *untainted* field of science is not just poor policy, but intrinsically bad.[2] They are consumed with the notion that current trends threaten to undermine not simply an effective set of institutions, but ultimately a successful part of our shared public life-what they might characterize as

[1.] See Donald Kennedy, "Research in the Universities: How Much Utility?" in *The Positive Sum Strategy: Harnessing Technology for Economic Growth*, ed. Ralph Landau and Nathan Rosenberg (Washington, DC: National Academy Press, 1986); and Leonard G. Boonin, "The University, Scientific Research, and the Ownership of Knowledge," in *Owning Scientific and Technical Information: Value and Ethical Issues*, ed. Vivian Weil and John W. Snapper (New Brunswick, NJ: Rutgers University Press, 1989), p. 253.

[2] See, e.g., Martin Kennedy, *Biotechnology: The University-Industry Complex* (New Haven: Yale University Press, 1986); and *Commercialization of Academic Biomedical Research* (Hearings before the Subcommittee on Investigations and Oversight and the Subcommittee on Science, Research, and Technology of the House Committee on Science and Technology, Ninety-

an important cultural achievement of post-World War II democracy. To some extent, this view finds expression in the recently renewed interest in eliminating patents for scientific research directed toward isolating and characterizing human genes.[3] Even those who would shy away from this grand form of the argument contend that regardless of the greater significance of scientific institutions and their historical achievements, those institutions have a uniquely appropriate place in our social setup. And that place, all on this side agree, is the *public sphere.*

As with so many issues, divergent vocabularies conceal similarities. Both the high-principle defenders of traditional public science and their utilitarian/economist fellow travelers share a sense that current trends pose a threat. For purposes of this essay, that is enough to provide a starting-point. Although as I proceed I will try to keep in mind the two very different motivations that lead to attacks on current trends in the direction of scientific research and the institutions that conduct it, the essay must ultimately reflect my sense both that the two sets of concerns motivate very similar policy arguments, and that at some level they are in fact closely intertwined.

In any event, with this quick summary of the current discontents of science behind us, we can turn to a statement of the burden I wish to carry in this essay. Simply put, the burden has two parts: first, to show that the public sphere spoken of respectfully in traditional science is less than it appears, being in fact more analogous in some ways to a limited-membership, shared-access common area than a truly wide-open, *unclaimed* space; and second, to argue that even under such a revised view of the public sphere, some current practices-broadly cognizable under the heading of privatization or (less accurately) commercialization-do indeed threaten to undermine certain cornerstones of our scientific infrastructure. In short, although the shape of the worry is different from the one commonly supposed, it is a real worry nevertheless. To some extent, I argue, the scientific community has begun to address these concerns itself, primarily through a host of voluntary practices that, in effect, water down patent rights. Yet enough of a threat remains that, toward the end of the essay, I propose some policy directions that might alleviate the

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seventh Congress, First Session, 1981), pp. 62-63 (testimony of Dr. Jonathan King, Professor of Biology, Massachusetts Institute of Technology):

> The openness, the free exchange of ideas and information, the free exchange of strains, of protein, of techniques, have been a critical component in the creativity and productivity of the biomedical research community... This freedom of communication stemmed from the fact that all of the investigators shared the same professional canon: the increase of knowledge of health and disease for the general benefit of the citizenry...

[3]See Sally Lehrman, "Broad Coalition Adds Voice to Religious Protest on Gene Patents," *Biotechnology Newswatch*, June 19, 1995, p. 1, in which Lehrman quotes Richard Levins, Professor of Population Science at the Harvard School of Public Health, as stating that gene patenting is a means of "subordinating a common intellectual heritage for private gain."

creeping propertization that characterizes science today. Perhaps not surprisingly, given my understanding that even traditional “pure” science includes de facto (though skeletal) property rights, I do not recommend the complete elimination of all property rights, formal and informal, from basic scientific research. Instead, I argue for a more carefully crafted set of property rights, including (1) a generally available exemption from patent infringement liability in the case of pure research conducted with federal funds (a broad form of the so-called “research exemption”), and (2) an occasional decision by senior science officials to exclude particular research areas from patentability altogether, when the direct and indirect costs of establishing, enforcing, and administering property rights is deemed excessive in comparison to the benefits of access under the "normal" rules of basic science. The recent decision by the director of the National Institutes of Health (NIH) to drop a series of patent applications on aspects of the Human Genome Project serves as an example of reasoned policy in this regard.

II. THE PUBLIC SPHERE, THE SCIENTIFIC COMMONS, AND FORMAL PROPERTY RIGHTS

For most people, the description of science as an innately public enterprise comes quite naturally. This is most likely a function of two attributes widely associated with scientific research: government funding and open dissemination. These are closely related, of course; but a moment's reflection ought to show that they are not coextensive. After all, there are activities that are funded by the government that are not publicized (e.g., intelligence work), and the private sector funds a fair amount of scientific research that is published in peer-reviewed journals and otherwise bears the earmarks of public availability. In other words, the implicit pairings "public/open" and "'private/closed" are misleading.

The large volume of privately funded basic research apparently does not undercut the view of science as an inherently public undertaking. Because of this, it might even be argued that the open dissemination of research results-which is, of course, common to most basic science, who ever funds it-is thought by most to be the key indicator of basic or pure science.

The point here is not to quibble with this, but to unpack it. That is, I am concerned in this section with a brief description of how and under what circumstances basic research results are shared with the world. As we shall see, it is a much more limited, and closely regulated, form of disclosure than is usually imagined. The many limitations on truly public dissemination lead, in fact, to the conclusion that science is not so much given freely to the public as shared under a largely implicit code of conduct among a more or less well-identified circle of similarly situated scientists. In other words, we will come to see that science is more like a

Limited-access commons than a truly open public domain. Later we will see how this revised understanding of the traditional degree of scientific openness contributes to our understanding of what policies should be adopted to stem the tide of current abuses.

A. The nature of scientific research

Science is a highly competitive enterprise regulated by a complex set of professional norms. Indeed, because of the elegant elaboration of those norms-especially at the hands of sociologists of science, particularly Robert Merton-they are sometimes confused with science itself.

Merton[4] described four norms that define the scientific culture: universalism, communism, disinterestedness, and organized skepticism. Briefly, "universalism" means that impersonal criteria, independent of the identity and characteristics of the individual scientist(s) who does the research, are employed to judge the soundness of scientific work. "Communism" means that scientific findings are made open to all, immediately, with no sense that they are or should be proprietary in any way. “Disinterestedness” means that scientists pursue truth rather than self-interest, that they are ideally indifferent to the success of an experiment or the reception of a research finding. "Organized skepticism" means that the scientific community should rigorously test research results before accepting them as true, and that all research is in some sense "born in doubt," false until dispositively proven true.

Of course, norms (in the sense in which Merton used the term) are aspirational; they have-to notice the linguistic clue-a normative dimension. Consequently, it is not surprising that sociologists of science have documented a set of practices that deviate in many respects from the norms Merton identified. Of most interest to us here is a set of observations made by the sociologist Warren 0. Hagstrom[5] on what might be called proprietary practices in science. Hagstrom states:

> Scientists who are concerned about the possibility of being anticipated as a result of the theft of their ideas tend to be secretive. An organic chemist [in an interview] said that he only communicated with persons he was friendly with and could trust....
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> To the extent that scientists can establish property rights over work in progress, they need not fear anticipation. Such property rights may be more or less explicit and formal.... When it becomes evident to two [scientists in the same field] that their research will probably produce the same results, they may informally agree on a division of labor... [Another way scientists treat their work as proprietary is by

[4] Robert K. Merton, *The Sociology of Science* (Chicago: University of Chicago Press, 1973).
[5] Warren 0. Hagstrom, *The Scientific Community* (New York: Basic Books, 1965).

> publishing a preliminary version of research in an abstract.] The latent function of publishing abstracts is to permit individuals to “stake a claim,” establish property rights on research in progress.[6]

Hagstrom concludes with the observation that "[s]cientific knowledge is community property. Discoverers have limited rights, but among them are rights to be recognized for their discoveries." Thus, we can summarize Hagstrom's findings by saying that he found certain proprietary impulses at work beneath the surface of the otherwise Mertonian world of shared, or public, science.

More recently, the practice of asserting informal property rights appears to have become even more prominent .[7] In cutting-edge biotechnology research, for example, pre- and even post-publication practices with respect to biological materials useful to fellow researchers (such as genetically engineered mice, or particularly useful cell lines) reflect greater reluctance to share widely. While it is difficult to trace the contours of a practice that few scientists admit to, and that few even seem willing to discuss openly, several operational principles can be traced, if somewhat speculatively. First, the more expensive and difficult it is to create a given biological material, the less likely it is that it will be shared widely and quickly.[8] Second, the creator of a biological material is more likely to share quickly with those in fields unrelated to the creator's central interests; property rights are asserted most forcefully, in other words, with direct competitors.[9] Third, despite the increased assertion of informal property rights, these rights still fall far short of absolute exclusivity. A recent investigation of sharing practices in the field of recombinant DNA research “reveals that while no makers of [mice] simply refuse to share them, some researchers substitute their own policies for those of [the National Institutes of Health, which mandates free access after publication]: not sharing mice until long after publication, or sharing mice selectively.”[10] In practice, then, this example suggests that scientists fall short of the ideal of instantaneous, widespread disclosure.

Of course, the most obvious illustration of creeping propertization is the now widespread practice of seeking *formal* property rights-in the

[6] *Ibid.,* pp. 87,91.

[7] Jon Cohen, "Share and Share Alike Isn't Always the Rule in Science; Many Researchers Fail to Share Materials," *Science, vol. 268* (June *23, 1995),* pp. 1715-18.

[8] *Ibid.,* p. 1715*:* "A National Research Council (NRC) report last year on problems with sharing genetically engineered mice such as knockouts [i.e., mice genetically engineered to have immune systems lacking a defense against a disease, used to test drugs aimed at treating that disease] concluded that 'increased cost and competition ... appear to be challenging the tradition of sharing in some branches of biological research.”

[9] See *ibid.,* p. 1717, where Cohen recounts the story of the creator of a research mouse who directed his graduate student to "initially [turn] down [a] request because [the requestor] was a direct competitor; that researcher was later given the mouse for a specific experiment in an area unrelated to [the creator's work or that of his graduate student]."

[10] *Ibid.,* p. 1716.

form of patents-over research results. Nothing could be further from the aspirational norm of openness. Indeed, the absolute exclusivity of a patent would seem entirely inconsistent with the earlier observation that science is characterized by informal property rights. Yet the truth is that in general, within the community of researchers, potentially patentable and even patented research results are often shared, though on a more limited basis. Surely it would be stretching quite a bit to argue that the presence of patents does not make a difference in the conduct of science. Yet just as surely it would be wrong to say that patents lead researchers to completely shut off the exchange of research results. Nor are patents universally enforced to the hilt among researchers; far from it.

As the studies cited earlier reveal, patents have affected the way science is done. Even so, in many cases scientist-patentees assert far less than the full exclusionary force bestowed by the legal system via their patents. A limited set of rights is asserted against the community, even though the patentee holds a greater set of rights. Indeed, it is not stretching too far to argue that conduct in today's scientific community in many cases approximates the effect achieved under the older practice of establishing "informal" property rights. The difference is that, now, the "informal ness" of the rights is achieved by relinquishing (or at least not asserting) some of the scientist's formal rights. It is as if the old practice of establishing minimal property out of a background of zero formal rights has been replaced by relinquishing some rights against a background of a strong, formal entitlement.

Several recent uproars in the science world illustrate the community's continued practice of costless sharing, even in the presence of patents. Arguments over conflict-of-interest policies,[12] the appropriateness of university patent-licensing policies,[11] and the licensing of patents for certain foundational research technologies reveal that the creeping propertization identified earlier has not yet reached into every aspect of community practice.

Like the internal tensions identified by sociologists of science in the pre-patent era, contemporary arguments are almost always a matter of degree. Very rarely is it argued that a member in good standing of the public research community is simply shutting the community out entirely. The debate centers on the terms of access, and on whether the restrictions some researcher seeks to impose are in keeping with the operational content of the norm of shared knowledge as currently practiced, even in the presence of patents. Again, the point is that few scientists see the debate in polar terms-as a simple choice between the total

[11] See, e.g., Student Note, "Ties That Bind: Conflicts of Interest in University-Industry Links," *U.C. Davis Law Review*, vol. 17 (January 1984), p. 895.

[12] See, e.g., Carl Dierassi, "The Gray Zone: Academic Researchers and Private Enterprise," *Science*, vol. 261 (August 20, 1993), p. 972.

absence of property rights (or their equivalent) and the wholesale adoption of strong, formal property rights (in the form of patents). Most scientists seem to think that the optimal policy entails maintaining some of the traditional practices that sociologists have identified with-an informal set of property rights in research results, even in an era when *formal* property rights have been widely adopted.

For example, a number of brushfires have broken out in recent years regarding the extent to which a researcher must make his or her results available to other members of the community prior to, or even after, publication. Since major research results-finding a gene, or identifying the active portion of a protein coded for by a gene of interest, for example-are usually published very quickly, they are not usually at issue. Instead, the arguments are over another issue: the dissemination of assays, reagents, and other research tools of the trade, which have come to be known generically as biological materials. Very often these are developed as an interim step on the way to the final goal of obtaining the gene or protein subunit or whatever. Since most of the basic research funding that goes into the creation of these tools is public money, the question arises: When must they be shared?

Often the discussion takes the form of back-channel gossip regarding a certain lab's unwillingness to share a research tool.[13] Interestingly, for our purposes, the point of this gossip-induced social pressure is *not* that the tool must be described in a formal, printed publication. It is simply that the tool be provided, on a reasonable basis, to other interested labs so that they can use it in the course of their research. Indeed, other labs understand that they will almost always be required to use the biological material under a duty not to disclose it to others, and certainly not to disclose it to the public generally, until its originator has published a full account of it.[14]

[13] See, e.g., Cohen, "Share and Share Alike Isn't Always the Rule in Science," p. 1715:

> [P]roblems in materials sharing ... crop up in cell-line repositories, crystallographic databases-indeed wherever competitors would like to share research materials. And these problems stir passions in the scientific community. "Typically, over coffee or beer at night, this is what our colleagues are talking about," says one researcher at the University of California, Berkeley, who insisted on anonymity.

Science's investigation, however, reveals that, e.g., "while no makers of [the genetically engineered mice known as "knockouts"] simply refuse to share them, some researchers substitute their own policies for those of NIH: not sharing mice until long after publication, or sharing mice selectively. Insiders in the field -none of whom would allow themselves to be named -repeatedly mentioned Nobel prize-winning immunologist Susumu Tonegawa as someone whose mice are not freely available immediately after publication."

[14] See Dan L. Burk, "Misappropriation of Trade Secrets in Biotechnology Licensing," *Albany Law Journal of Science and Technology, vol. 4 (1994), pp. 141-42:*

> The professional norms of the scientific community have long required that scientists share data and materials with one another, both to allow repetition and validation of reported results and to facilitate new discoveries.... These exchange practices have to

Insider criticism of other contemporary practices is aimed at the same goal of limited access. Thus, the controversy over inadequate disclosure of research tools employed in the discovery of published research results subsided when certain benchmark publications such as *Science* agreed to require researchers to simply make the tools available with a reasonable set of restrictions.[15]

The same pattern holds when the patenting of research results is at issue. Normally, the criticism of excessive patenting activity or inappropriate licensing practices does not start from the assumption that complete public access should be the norm. For example, the outcry over certain large-scale research funding arrangements between private industry and prominent research institutions does not assume that the research output of the institutions would be freely available to all in the absence of the funding agreement. Implicit is the notion that the agreements exceed standard limits on the *degree* of privatization that is acceptable in science. No one assumes that a modest degree of privatization is against the working norms of the community.

This makes an interesting backdrop to our consideration of a historical moment when it appeared that policymakers might adopt formal, statutory property rights for scientific research.

B. History of explicit proposals for formal property rights in scientific discoveries

Traditionally, the findings of pure scientific research have been excluded from patent protection.[16] Some have proposed that it is a mistake to exclude such things, however. The history of these attempts to extend formal rights to the products of scientific research bears recounting for two reasons. First, it shows once again that despite the norm of openness (or "communism," to use Merton's term), property rights-even of the formal variety-have not been a complete stranger to the world of science. Second, certain objections to these earlier proposals seem just as valid now as when they were first made. The upshot is that this older debate holds some useful lessons for the current discussion.

The movement for formal property rights in scientific discoveries took shape in France just after World War I, when scientists were suffering greatly from the national devastation (and destitution) brought on by the

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some extent been constrained by an unwritten and often unspoken agreement among researchers that the materials shared will not be used for commercial gain and will not be passed on without permission from the original owner.

[15] *Ibid., p. 142.*

[16] See Robert P. Merges, *Patent Law and Policy* (Charlottesville, VA: Michie Co., 1992), ch. *2.*

war.[17] The movement received formal recognition in 1922, when a detailed legislative proposal was introduced into the French Chamber of Deputies by J. Barthelemy, a French law professor and Member of the Chamber. Professor Barthelemy's proposal would have overturned a provision of the French Patent Law of 1844 which declared null and void all patents concerning "principles, methods, systems, discoveries and theoretical or purely scientific conceptions of which no industrial applications are indicated."[18] Barthelemy's proposal contained two essential provisions. First, it stipulated that a scientist who has made a discovery may take no action so long as no one tries to apply the discovery. As soon as a practical application of the theoretical discovery is made, however, the scientist may present a claim for a part of the profits. Second, a scientist may obtain a "patent of principle." This would not confer on the patentee an exclusive right to make or use the discovery, but only the right to grant licenses for those utilizing the practical applications of the discovery. Anyone would be free to utilize the invention or discovery, so long as he or she paid royalties to the scientist who had discovered it. The duration of protection would have been more akin to copyright: the life of the discoverer plus fifty years. As intellectual-property scholar Stephen Ladas points out, the Barthelemy proposal was part of a larger post-World War I movement in France in favor of a "Droit de Suite" or set of "moral rights" for authors and creators.[19]

Also in 1922, the League of Nations' Committee on Intellectual Cooperation took up the question of scientific property at the insistence of its chairman, Professor Bergson. The committee eventually approved a plan drafted by Senator Ruffini of Italy.[20] Ruffini's proposal began by dismissing the theoretical objections to the patenting of scientific discoveries. After reciting the various objections to protecting "discoveries" rather than inventions, Ruffini concludes: "The whole question is dominated by crudest utilitarianism, empiricism unhappily disguised in scientific nebulosity, and, finally, the most disconcerting arbitrariness."[21] Ruffini also pointed out that one objection to the proposal of Barthelemy in France was that French industry would be handicapped by being forced to recognize an intellectual property right not recognized throughout the world. Ruffini's solution was to propose an international treaty which would

[17] This and other details of the early movement for property rights in science are drawn from C. J. Hamson, *Patent Rights for Scientific Discoveries* (Indianapolis: Bobbs-Merrill Co., 1930).

[18] Quoted in Stephen P. Ladas, *Patents, Trademarks, and Related Rights: National and Inter national Protection* (Cambridge: Harvard University Press, 1975), vol. 3, p. 1856.

[19] Ladas, *Patents, Trademarks, and Related Rights,* vol. 3, section 1012, p. 1856.

[20] F. Ruffini, *Report on Scientific Property* (Committee on Intellectual Cooperation, League of Nations, Document A. 38, 1923), XII, 10; quoted in Ladas, *Patents, Trademarks, and Related Rights,* section 1012, p. 1856.

[21] *Ibid.*

create such a right in all signatory nations, thus eliminating the possibility that companies in one country would carry the extra financial burden of paying royalties to scientists.

Ruffini's substantive proposals were straightforward. He proposed a term of protection identical to that of Barthelemy's plan: life plus fifty years. He called for the exclusion of discoveries which merely presented a scientific explanation of obvious facts or practices of human life. (This point was made in response to a memorandum from Dean Henry Wigmore of Northwestern Law School, who objected to the proposal on this basis.) In addition, the plan provided for four possible means of establishing priority in an idea, including publication, self-authentication, "patents of principle," and ordinary patents.

While these proposals drew criticism, they also found defenders. One view had it that the industries that used a scientific discovery in particular applications had a "quasi-contractual obligation" to remunerate the discoverer of the principle.[22] In fact, the plan went so far as to be made the subject of a draft convention prepared by a committee of experts at the League of Nations.[23] However, the project lost momentum in 1930, and was never revitalized, except in France. There the government adopted a decree creating a Medal of Scientific Research with prizes, which took the place of the discovery patent. This decree, and certain legislated principles in the socialist countries, are the only actual legislative products of the scientific-discovery patent movement.[24]

A number of authors familiar with these proposals from the 1930s have raised or reviewed objections to them.[25] First, it is very often difficult to trace the scientific origins of a particular industrial application. Second, there is a significant lag time between the disclosure of a scientific discovery and the development of the first application; the argument that fairness dictates compensation for the scientist who makes a discovery would seem to be mitigated by the length of time between his or her discovery and its application. Third, very often it can be assumed that a scientific disclosure will be missed by industrialists; they will thus end up paying royalties for a scientific discovery which in fact was not relied upon in creating their industrial application. And finally, the very significant burdens on scientific communication that a system of property rights would create represent perhaps the most severe problem. Since science was (and still is) thought to depend on free and open communication, and since property rights are presumed to be at odds with such free

[22] See Laclas, *Patents, Trademarks, and Related Rights,* section 1017, p. 1862.

[23] *Ibid.*

[24] See *ibid.,* sections 1021-26, pp. 1868-75. It should be noted that Article 2(viii) of the convention establishing the World Intellectual Property Organization (WIPO) includes, in the definition of "intellectual property," rights relating to "scientific discoveries" and "all other rights resulting from intellectual activity in the ... scientific ... fields."

[25] See Hamson, *Patent Rights for Scientific Discoveries;* and Ladas, *Patents, Trademarks, and Related Rights.*

communication, property rights and science were thought to be an ill-fated combination.

An additional objection to patents in scientific discoveries is that they are not necessary to spur scientific research. As Judge Jerome Frank put it:

> Epoch-making "discoveries" or "mere" general scientific "laws," without more, cannot be patented.... So the great "discoveries" of Newton or Faraday could not have been rewarded with such a grant of monopoly. Interestingly enough, apparently many scientists like Faraday care little for monetary rewards; generally the motives of such outstanding geniuses are not pecuniary... Perhaps (although no one really knows) the same cannot be said of those lesser geniuses who put such discoveries to practical uses.[26]

On this view, granting patents for discoveries that scientists *would have made anyway* would be socially wasteful.

For many, this latter assumption would be far less defensible in today's environment of tight federal budgets. Regardless of what *motivates* a scientist, the argument would surely run, he or she cannot make any progress in the vast majority of scientific disciplines without a great deal of money. Equipment, personnel, and the like-all essential to the performance of modem science-are very expensive. Thus, since adequate funding is essential to science, society will not receive the results of scientific research without either extensive public support or some other revenue source. It follows that if property rights can secure this alternative revenue source, they may well provide a necessary impetus for the performance of research. Far from being redundant-an unnecessary reward, heaped on a researcher who would have done the same work without it-they may well be essential. This of course moots Judge Frank's objection to the granting of rights for pure scientific finding.

If it is true that property rights are increasingly essential to the research endeavor, it is no less true that these rights will bring with them a host of problems. It is these problems-which I would describe as an entire family of new *transaction costs*-which drive the discussion in Section IV concerning policy solutions to the imposition of property rights in science.

C. The rise of patents for the results of "pure" science

Proposals to explicitly allow patents for the results of basic scientific research eventually faced a resounding defeat. Given that the only occasion on which the appropriateness of these patents was discussed in detail yielded such negative results, it is perhaps surprising that basic research is now considered an entirely proper source of patentable subject matter. Although broad statements of scientific truth-such as $E = MC^2$-

[26] *Katz v. Horni Signal* Mfg. *Corp., 145* F.2d 961, 63 U.S.P.Q. (BNA) 190 (2d Cir. 1944).

are still considered unpatentable,[27] many of the fruits of contemporary basic science find their way into patent claims of one variety or another these days. To some extent, this is a result of growing sophistication by patent lawyers, who have learned to state a scientific finding in terms of an at least nominally useful application.[28] Apart from this, however, what happened to produce this de facto change in policy?

For the most part, the answer lies with changes in the relationship between science and technology since the 1930s .[29] In the 1930s, the important science-based industries were centered around the electrical and chemical fields. Because electrical engineering and modem, analytic chemistry were still very young, the findings of basic science were very basic indeed. The conceptual distance between basic research and applied technology, in other words, was very large. As a consequence, huge investments were required to translate the findings of the basic research laboratory into viable commercial products.

By the 1970s and 1980s, however, the relationship between science and technology had grown a good deal closer in many fields. In important fields such as biotechnology and certain branches of physics, the jump from lab result to commercial product was much shorter than it had been in the past.[30] Thus, for example, the basic Cohen-Boyer research on gene-splicing led to a commercial product (genetically engineered insulin) in only a few short years. The early work on lasers, to take another example, yielded commercial results after a relatively short time as well.

In addition, a host of subsidiary factors contributed to the hastening rate of commercial application. One important factor-often overlooked -is the change in the ease of capital formation for science-intensive industries.[31] In the 1930s, it was widely thought that only large, integrated companies could afford the "luxury" of long-term-oriented basic scientific research. By the 1970s, however, with the advent of the venture-capital industry and related support institutions, start-up companies based on new scientific findings often found a ready supply of capital from firms specializing in such speculative investments. Genentech, founded in the mid-1970s, is of course the paradigm. It is also an example of a technology-intensive start-up that was later highly touted by investment analysts when it made the jump from "private" to public financing, via an initial public offering of stock.

[27] See Merges, *Patent Law and Policy,* ch. 2.

[28] This is the legal test used to determine patentability in close cases involving a putative "scientific principle." See *ibid.,* ch. 2.

[29] See Robert Teitelman, Profits *of Science: The American Marriage of Business and Technology* (New York: Basic Books, 1994).

[30] See *ibid., p. 8,* where Teitelman contrasts the 1953 elucidation of the structure of the DNA molecule by James Watson and Francis Crick, which had no commercial impact until decades later, with the 1973 Cohen-Boyer work on recombinant DNA, which led to the founding of Genentech in 1976.

[31] See *ibid.,* ch. 1.

As the Genentech story illustrates, capital markets-together with the changing interplay between science and technology-played a crucial role in the commercialization of basic science. It is important to recognize that extensive university involvement in technology licensing-another recent development often said to be at the heart of the commercialization process-is in fact closely related to the growing sophistication of capital markets with regard to basic science. For it is quite clear that without a prospective market, fueled by the idea of significant returns on investments in the basic findings of science, the university licensing offices founded with such frequency in the 1980s and 1990s would have no one to sell to.

These licensing offices demonstrate the extent of the changes that have taken place within many areas of basic science since the 1930s. Far from needing special legislation to create a new branch of patent law, the laboratory findings of certain branches of modern science fit comfortably within the contours of traditional patent law. Once the science/technology interface grew closer, and capital was attracted, obstacles to patentability largely dropped away.

D. Incentives to seek property rights despite community norms

Despite the fact that, for a variety of reasons, patents are now available for an increasing proportion of the results of basic research, the community norm of open access remains strong. Thus, it is perhaps not clear why, even though the operative legal standard has changed vis-a-vis modem science, scientists and the institutions that employ them today are seeking so many patents for their research. In other words, just because they *can* obtain patents, it does not follow that all of them *will*. Why then is everyone, in fact, making more and more use of the patent system?

The answer as I see it is fairly simple. The increasing value of patents makes adherence to the traditional community norm of nonproprietary open access implicitly more expensive. Thus, even if a particular scientist believes strongly in adherence to the norm, he or she knows that others will be tempted to ignore it because of the higher payoff that stems from seeking a patent. Since many scientists believe that although the norm is still the “correct” mode of behavior, many of their colleagues will abandon it, even those scientists who believe in the norm may well abandon it. Only a scientist who would revel in the thought that he or she was the last one remaining who adheres to the norm would continue to adhere to it.

Those familiar with the logic of game theory will recognize the basic structure of this situation. Although most players attribute the greatest value to continued shared access -to "cooperation," in game theory lingo-even many of these, fearing the inevitable abandonment of the shared norm in light of the higher individual payoffs from "defecting," will themselves defect from the prior cooperative arrangement. Others, anticipating

this, will also defect. In this way, even though everyone would be better off if the cooperative behavior continued, the "equilibrium strategy" will be to defect. The problem, to put it simply, is that there is no way to enforce the norm of shared access, and no way to bind other members of the community to the cooperative arrangement. The players must rely on each other to continue to do the right thing without formal sanctions for doing otherwise. Once the payoffs from defecting increase, however, there is less assurance that the other players will continue to do the right thing. One way of stating this is that the implicit costs of the informal sanctions brought to bear on defectors-negative gossip, loss of reputation, etc.-are outweighed by the benefits, in the form of greater payoffs due to the enhanced returns provided by the formal property rights. As one highly astute observer of these matters put it recently:

> For years biomedical research has flourished while investigators have drawn heavily upon discoveries that their predecessors left in the public domain. Even if exclusive rights enhance private incentives to develop further research tools, they could do considerable damage to the research enterprise by inhibiting the effective utilization of existing ones.[32]

There is already evidence that this dynamic has begun to set in.[33]

Since scientists may well conclude that it is in each scientist's self-interest to patent his or her research tools, each will expect the others to avail themselves of patents. This expectation that others will defect leads even those who rue the demise of the norm of cooperation to defect, since the very worst position of all is to continue to cooperate while all those around you are defecting. In the case of patents on pure science, this would take the form of a scientist refusing to patent her results despite the fact that all her colleagues are patenting theirs. She would have to pay royalties to all the others to use their results, while her own work went completely uncompensated. Indeed, if royalty income were a substitute for research funding from the government or the like, she might even be

[32] Rebecca Eisenberg, "A Technology Policy Perspective on the NIH Gene Patenting Controversy," *University of Pittsburgh Law Review, vol.* 55 (Spring 1994), p. 646.

[33] Jim Carlton, "Roche Brings Leading Institutions into Lawsuit over Patent Rights," *Wall Street Journal,* May 25, 1995, p. B4:

> At a conference here this week, scientists reacted with dismay [to a suit brought by Roche against Promega, another biotechnology company, in which Roche accused Promega of "contributory infringement" by supplying scientists with a key component that allows them to use Roche's patented polymerase chain reaction (PCR) technology], saying they could be prevented from using patented products-such as for computers and biotechnology-in their scientific research. They say they have done research virtually unfettered by patent constraints for some 200 years.

Note that many of these scientists -or at least the institutions where they work -are actively seeking patents on the results of *their* research. In other words, they are dismayed that their own strategy of defecting from the cooperative arrangement is becoming the norm!

driven out of science altogether. Thus, she might well adopt the approach of patenting her research despite deep misgivings about abandoning the traditional norm of openness in science.

Even if this account of the motivations of individual scientists is correct (and it is admittedly highly stylized), some important questions remain. Just because patent law has in effect dropped its objections to patenting what comes out of certain basic-research labs, and just because scientists might have an incentive to patent, does that mean that the science community, or society at large, should encourage widespread patenting of these results? Are there policy concerns that extend beyond the domain of what patent law considers appropriate subject matter? I take up these questions in Section IV.

A recent development illustrates how scientists and research labs are responding to the incentives they face. In March 1995**,** a group called the Association of University Technology Managers (AUTM) announced a new, standardized form for the transfer of biological materials between nonprofit (i.e., government-funded) research labs.[34] The Uniform Biotechnology Materials Transfer Agreement, or UBMTA, embodies the research community's current sense of the best practices with respect to the sorts of limitations that can appropriately be placed on the transfer of research tools created with public funding.[35] For our purposes, two features of the UBMTA scheme are of paramount importance. First, there are two versions, one styled "nonprofit to nonprofit," and the other "nonprofit to for-profit." (I explore this two-tier property rights regime in Section III.) Second, the UBMTA recognizes a number of serious restrictions on use-incursions into the pure public domain, if you will.

For example, in the "nonprofit to nonprofit" form, free use is given of the research tool in its original form, but adaptations, modifications, and alterations are not covered. Indeed, modifications intended for ultimate commercialization are to be the subject of negotiations with the original provider of the material. And, perhaps most relevant here, the relatively permissive treatment of transfers applies only if the transferee does not intend a subsequent transfer to a private, for-profit firm. These private firms, being outside the common in some sense, must negotiate formal, commercial licenses.

[34] On lab transfer agreements, see Charles E. Lipsey et al., "Protecting Trade Secrets in Biotechnology," in *Protecting Trade Secrets* (PLI Patent, Copyright, Trademarks, and Literary Property Course Handbook Series No. 224,1986), Exhibit K.

[35] This uniform MTA suggests that standard contractual terms-a form of transaction-cost-reducing industry coordination-are beginning to emerge. (My source here is a personal interview with Sandy Shotwell-an AUTM member and a participant in the project to draft the Uniform Biotechnology Material Transfer Agreement (UBMTA) -conducted in Washington, D.C., in February 1994.) On the evolution of transaction-cost-reducing institutions and practices in intellectual property-intensive industries, see Robert P. Merges, "Of Coase, Property Rules, and Intellectual Property," *Columbia Law Review,* 1994, p. 2655; and Robert P. Merges, "Intellectual Property and the Costs of Commercial Exchange: A Review Essay," *Michigan Law Review, vol.* 93 (1995), p. 1570.

E. Contemporary research on common-property regimes

This description of contemporary trends and understandings in science should give some hint of why I have come to see science as a limited-access commons, rather than a truly open public domain. In this subsection, I shall briefly review some contemporary scholarship on common-access property rights regimes, both to get a deeper sense of how the analogy works and to frame the discussion in Section IV concerning proper policy toward scientific research.

Throughout the 1970s and into the 1980s, much of the research in political economy, the economics of the public sector, and economics in general led to a great deal of skepticism toward the workability not just of government, but of collective institutions in general. At the formation stage, institutions were faced with formidable problems, most notably the difficulty of overcoming self-interest; the problem of collective action, we were told, was pervasive. And if by some miracle of cooperation or coercion collective institutions took shape, they were immediately besieged by rent-seeking interest groups concerned exclusively with turning the institution to private advantage. The forces at work during the operative stage of an institution-which we might generally refer to as public-choice concerns-were thus just as corrosive as the original conditions of collective action.

Partly in response to the deep skepticism engendered by the collective-action and public-choice literatures, a number of social scientists set out to study real-world institutions to see how they worked. Some started inductively, arriving at the threshold of the theory of institutions only after having accumulated a mass of facts. Others began with a sense that the received wisdom was somehow deficient; they seemed to have in mind the old adage that sure, it worked in practice, but would it work in theory?

Whatever their starting point, however, these social scientists soon began to assemble an intricate factual basis for some major revisions to the received view of institutions. In sociology, economics, and even legal studies (with the work of scholars such as Robert Ellickson at Yale Law School), detailed studies of institutions took shape.[36] Collectively, they form the basis for a much more nuanced theory of institutional formation, administration, and change. As if to ratify the trend, the Nobel economics committee last year awarded its prize to the granddaddy of institutional theorists, economic historian Douglass North.

Many of the trends that culminated with the award of the Nobel to North are on display in Eleanor Ostrom's pioneering book, *Governing the*

[36] See Robert Ellickson, *Order without Law* (Cambridge: Harvard University Press, 1989); and Thrairm Eggertsson, *Economic Behavior and Institutions* (Cambridge: Cambridge University Press, 1990).

Commons.[37] The thrust of Ostrom's work is a description of how voluntary institutions arise to allocate scarce, commonly shared resources such as water, without formal property rights or significant government oversight. Her cases reveal a rich pattern of adaptive, consensual responses to the "tragedy of the commons." Each case describes who organized the institution and why. Then Ostrom details the complex rules governing who can join, how informal "rights" to resources are determined, how compliance is monitored, how rules are enforced (e.g., how violators are sanctioned), and whether (and to what extent) "external"' governmental authorities are called on to structure, ratify, oversee, or enforce any aspects of the institution.

Because they mirror the operation of scientific research institutions in some ways, I will consider the example of water basin authorities in Southern California, a set of institutions Ostrom studies in detail. These institutions emerged out of a classic tragedy of the commons: an open access resource combined with minimal (almost nonexistent) property rights. Municipalities that shared these water basins-which are large, permanent subsurface water sources-formed water authorities in response to repeated litigation over how much water each city could appropriate under state law. This law was based on the notion of capture; it provided that a municipality had the right to use as much water as it could make beneficial use of, subject to the caveat that the total usage could not exceed the sustainable yield of the water basin. In the shadow of this minimal set of first-comer entitlements, and under the threat of continuous, litigation under the just-mentioned caveat, the municipalities formed voluntary organizations such as the Raymond Basin water district and the West Basin Water Association. After initially implementing proportional water-pumping cutbacks, to comply with the sustainable-yield requirement, these institutions assumed their current operational role. They now provide for fixed water allocations, neutral monitors (so-called watermasters, whose salaries are paid mostly by member cities but partly by the state of California), and even systematic investments in groundwater enhancement technologies, paid for by proportional contributions of the member cities. Although the influence of government can be seen in the formation and operation of these institutions, Ostrom stresses the essentially private nature of the collective action behind these institutions: "The solutions to the pumping race ... were not imposed on the participants by external authorities. Rather, the participants used public arenas to *impose constraints on themselves."* Ostrom's study of water authorities and the other common-pool organizations culminates in eight design principles, which Ostrom lays out as a checklist for institutional designers. These are her answers to the deficiencies of the received theory of institutions, especially collective-action theory and public choice. For our

[37] Eleanor Ostrom, *Governing the Commons* (Cambridge: Cambridge University Press, 1990).

purposes, what is important is that she demonstrates the operation of voluntary common-property resource allocation institutions based on shared rules and norms. (A host of other studies in the same vein reach quite similar conclusions.)[38]

F. Scientific research as a common-property resource

One could agree that the baseline in science is not complete openness, and still resist the analogy between common-property regimes and con temporary norms of science. After all, unlike water or common pasture land, scientific research is not a product of nature, waiting to be exploited. It has to be created. Thus, the thought might be that the institutions that operate in the realm of science cannot be legitimately compared to those that allocate access to preexisting natural resources such as water.

This is no doubt true; the analogy is incomplete in many respects, perhaps fatally so. There is, however, one similarity so important as to make it worth pursuing (in my mind, at any rate): the notion that both in the common-resource institutions studied by social scientists such as Ostrom and in the case of scientific research, the members of the community act as if some intermediate form of social organization -neither purely private nor completely nonprivate, i.e., public-is in force.

This shared assumption stems, at least in part, from the fact that although science itself is not a freely given asset, such as water or pasture land, it is based on a resource that the members of the relevant community treat as a given: public money. Thus, public funding produces science, which therefore carries with it some of the attributes of a public (or, I would argue, common) resource. True, unlike with a physical resource, where the only issue is allocation, science must first be produced by participants. And true, once it is produced, it must be disclosed in order for other members of the community to use it. Nevertheless, in many ways the practice of science makes these distinctions less important than they might at first appear. First, the production of science is a highly cooperative venture. Those who produce it understand that the community always has extensive claims on it, because without shared knowledge, research techniques, and even biological materials, there would often be no results, no progress, and hence nothing to argue about. Second, and most importantly, in the absence of shared norms, science, like water, would be subject to highly deleterious forms of self-serving behavior. A lab that always "takes" research results, but that never "gives" in return, for example, is like a municipality that pumps water as fast as it can, at the expense both of its neighbors and ultimately of rational

[38] See, e.g., Glenn Stevenson, *Common Property Economics: A General Theory and Land Use Applications* (Cambridge: Cambridge University Press, 1991), which presents empirical studies of grazing rights in common pastures. (The Ostrom quote earlier in this paragraph is from *Governing the Commons, p.* 110.)

water use. Thus, in science, as with open-access water resources, cooperation produces very large gains.

III. THE NEW NORMS OF SCIENCE: TWO-TIERED PROPERTY RIGHTS

In science, as we have seen, emerging pro-commercialization practices coexist (sometimes uneasily) with traditional "Mertonian" norms. The resulting set of practices, although still in the formative stage, suggests a basic structure that is quite compatible with Ostrom's institutional analysis. It is worthwhile to take a moment to reconsider these practices, then, with an eye to understanding them as an example of collective-action institutions in formation.

In essence, the new practices can be explained-roughly and preliminarily-in the following terms. They seek to preserve the old norms while recognizing a fundamentally changed landscape.[39] They do this by dividing potential transactions into two classes: those with other pure scientists, in which efforts are made to preserve the old rules of scientific discourse; and those with commercial entities, in which more-explicit insistence on property rights, and the attendant element of immediate compensation, are both expected. Consistent with the earlier explanation, it is important to notice that the former set of transactions are not in any sense *devoid* of property rights. Instead, they rely on informal property rights. The latter transactions, by contrast, depend on formal property rights, and are conducted "in the shadow of" these rights. This explains, for example, why transfers of as-yet-unpatented materials to commercial labs come with greater restrictions. The possibility that a patent might be sought leads to greater safeguards, such as an insistence that any commercialization, publication, or property right claims growing out of the commercial recipient's use of the materials come only after the sender has received notice and has time to respond. (This can preserve the sender's right to file his or her own patent, for instance, a right that might be endangered if the recipient makes the sender's invention public before the sender acts, e.g., by filing a patent application.)

Although I believe the two-tiered property right concept properly captures an important feature of contemporary science, I would add some warnings about its continued relevance. In general, science is in such a rapid state of flux that the differential treatment of pure and commercial science may only be a way station on the road toward a totally new set of

[39] In this respect, they bring to mind some intriguing observations of my colleague Bob Cooter regarding the formation of formal markets for property rights in Papua New Guinea, a country currently undergoing a transition from a traditional, clan-based system of real-property ownership to a more modem system. See Robert Cooter, "Inventing Market Property: The Land Courts of Papua New Guinea," *Law and Society Review, vol. 25* (1991), p. 760, where Cooter argues that the best approach to modernizing is for courts to encourage novel forms of market property that are more congenial to tradition."

practices. Perhaps the destination will be the complete specification and enforcement of property rights, against all comers, pure and commercial. Perhaps it will be a return to the old patterns of interaction, fueled by a declining interest in funding from commercial entities. The point here is that the two-tiered system I observe currently is only one possible configuration in the long term. Before extensive policy formation is undertaken in response to it, we should make sure it has some degree of permanence.

IV. SOME TENTATIVE POLICY IDEAS

What policy recommendations flow from the fact of "creeping propertization" of science, and the emergence of a two-tiered system? And what do we gain, in formulating policies, by seeing scientific research both as a common asset shared under strict rules by a close-knit community, and as a marketable product? I present the answers to these questions in two parts: first, a pair of formal policy proposals, and second, an admonition on implementation.

A. Specific policy proposals

First, we ought to consider adjusting some of the rules of the formal intellectual property system to better reflect the fact that science originates as a product of the commons. As is well recognized, the bold individual is the darling of our system, and of patent law especially. Yet the origin of scientific research is with the group, and its use and dissemination, in the first instance at least, ought to be a group affair. Thus, the common-property approach would lead us to consider very seriously proposals to formalize a line of legal decisions hinting at a *pure research exemption* to patent infringement.[40] While none of these proposals to date would explicitly allow fellow scientists to use research results notwithstanding

[40] See Rebecca Eisenberg, "Patents and the Progress of Science: Exclusive Rights and Experimental Use," University of Chicago Law Review, vol. 56 (1989), p. 1017, where Eisenberg describes the interaction between the scientific research ethos and intellectual property rules.

The pure research exemption to patent infringement, known as the experimental-use doctrine, had its origins in justice Joseph Story's opinion in Whittemore v. Cutter, 29 E Cas. 1120 (C.C.D.Mass. 1813) (No. 17,600). In this case, the defendant appealed a jury instruction which stated, in effect, that the "making of a machine ... with a design to use it for profit" constituted infringement. Justice Story upheld the trial judge's instruction, and stated that "it could never have been the intention of the legislature to punish a man, who constructed such a machine merely for philosophical experiments, or for the purpose of ascertaining the sufficiency of the machine to produce its described effects" (29 F. Cas. at 555). Other cases followed, generally limiting the exception to these quite narrow grounds. See Note, "Experimental Use as Patent Infringement: The Impropriety of a Broad Exception," Yale Law journal, vol. 100 (1991), p. 2169, which states that the experimental-use exception "should be applied as it has been in the past: in a very restrictive manner, consistent with the purpose and function of the patent system."

In Roche Products, Inc. v. Bolar Pharmaceutical Co., 733 F.2d 858, 221 U.S.P.Q. (BNA) 937 (Fed. Cir.), cert. denied, 469 U.S. 856 (1984), the Federal Circuit Court of Appeals considered

the presence of formal patent rights,[41] the "experimental-use doctrine" seems precisely the right sort of accommodation between the needs of the scientific community and the requirements of a formal property rights system. Whereas under current norms scientists in effect scale back their property rights when dealing with each other, the experimental use doctrine as typically described[42] scales back the rights that any patentee-commercial entity or pure scientist-can assert against a pure researcher. The doctrine could thus be described as having two primary effects: codifying current practices within the scientific community, and extending those practices to dealings between commercial entities and pure scientists.

The second proposal worth considering is to explicitly reevaluate the patent system's rule regarding how early in a research project a researcher can file a viable patent application. This rule, called the "utility requirement" by patent lawyers, plays a crucial role in mediating the boundary between academic (or pure) science and applied, commercially valuable science. Although there are some decided cases that show an appreciation that the requirement serves this role, there is as yet no thoroughgoing conceptualization along these lines. What is needed is an appreciation of the fact that pure researchers, long before it is clear whether they are actually infringing any patent, change their behavior upon the mere filing of a patent application by some other researcher or lab. They may shy away from the area covered by the patent application, in fear of eventual patent litigation; they may file a competing application, "defensively" as it were, to counter the incipient threat with a property right of their own; or they may be seduced wholeheartedly into the speculative game, and thus file a patent with potential commercial gain in mind-that is, an "offensive" patent.

The utility requirement does not prevent these results, it merely delays them. By requiring that an invention must reach a significant degree of practical promise before a patent application is filed, it at least prevents the kind of "race to the patent office" that is both theoretically predictable and actually observed in some cases.[43]

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the experimental-use defense for the first time. Here, the defendant, Bolar Pharmaceuticals, engaged in infringing acts prior to the expiration of the plaintiff's patent in order to facilitate Food and Drug Administration testing, so as to be ready to market the drug as soon as the patent expired. The Federal Circuit Court overruled the district court's finding of noninfringement, holding that the experimental-use exception did not include "the limited use of a patented drug for testing and investigation strictly related to FDA drug approval requirements . . ." (733 F.2d at 861).

[41] In fact, in "Patents and the Progress of Science," Eisenberg explicitly recommends that "[r]esearch use of a patented invention with a primary or significant market among research users should not be exempt from infringement liability when the research user is an ordinary consumer of the patented invention."

[42] See Eisenberg, "Patents and the Progress of Science."

[43] The most notorious recent case involves patents on short snippets of genetic material, which, it is hoped, will one day be identified as portions of larger, whole genes having commercial applications. See Rebecca Eisenberg, "Genes, Patents, and Product Develop-

B. "Open-access absolutism": A policy to avoid

In pursuing the policy goals outlined above (as well as others intended to address the same problem), I propose that we keep one important thought in mind: we must show respect for the internal rules of the scientific community. This will take the form, primarily, of *refusing* to adopt flat requirements that all federal scientific research, or even some portion of it, be made instantaneously available to the general public, or even to all other scientists. In other words, we must show an understanding that even if formal property rights are prohibited, a set of norms in the scientific community will continue to regulate access and related issues in ways that might be described as the imposition of certain *informal* property rights. Where this is so, we must respect it. Instead of conceiving of science as innately public, and therefore viewing any and all restrictions on public availability as inherently wrong, we should ask why the community does things the way it does. Some restrictions on dissemination-such as the prohibition on commercial use of shared biological materials-may well be designed to add to the amount and quality of science that is ultimately available to the public. Some practices, such as less-than-total disclosure of research tools upon publication, might have important roots in the incentive structure of individual scientists working in the context of the scientific community. (That is, in order to develop a new tool in the first place, scientists might need an extra advantage of exclusive use of a new research tool for some period beyond the first publication generated by use of that tool.) In any case, we ought to see how the practice under scrutiny evolved in the community, and how it affects the overall functioning of the community, instead of bluntly requiring that science adhere to the naive baseline of total and immediate public dissemination.

V. CONCLUSION

I have attempted to describe the emergence of a new set of practices, or norms, in the scientific community. This community, which is undergoing a process of "creeping propertization," has responded by adapting the informal norms that served it in the past to a new regime, one characterized by the presence of strong, formal property rights. I have argued that while science was never completely "open," and while "informal" property rights were asserted and recognized even in the older, precommercial era, the advent of formal rights has resulted in an uneasy, shifting configuration

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ment," *Science, vol. 257, p. 903;* Reid Adler, "Genome Research: Fulfilling the Public's Expectations for Knowledge and Commercialization," *Science, vol. 257 (1992), p. 908;* Thomas Kiley, "Patents on Random Complementary DNA Fragments?" *Science, vol. 257 (1992), p. 915;* and Bernadine Healy, "Special Report on Gene Patenting, *New England Journal of Medicine, vol. 327 (1992), p. 664.*

best described as a two-tiered system of rights. In the realm of "pure" research, the older practices involving "informal" property rights are still ascendant, though certain accommodations have been made, based on the shared understanding that what is pure today may have commercial potential tomorrow. In the main, in other words, there are signs that the scientific commons has been defended from the onslaught of propertization, at least for the time being. Dealings between pure researchers and those in the realm of commercial research are conducted on a different basis, however. They are based more on formal rights, and financial compensation (present or future) is an expected component of the relationship. In this case, when members of the commons deal with outsiders,[44] informal rights give way to formal rights. It is an interesting feature of the scientific community that its members can simultaneously maintain informal internal institutions for conducting exchange, and also conduct market transactions with those who are not members of the community.

I have also argued that the current accommodation may prove to be unstable, and that in any event it would be wise to consider certain policies that reflect the dual nature of contemporary science. In particular, I suggest giving some thought to proposals to formalize an "experimental use" defense against charges of patent infringement, for pure research scientists, and I suggest reconceiving the utility requirement in patent law to hold the line on early patenting, and thus preserve the two-tiered structure scientists seem to be converging on. These and other policy ideas are well worth considering when one takes into account the enormous contributions made by science to social welfare in the past several hundred years. It is also worth considering that the institutional and legal foundation on which science rests plays an important part in bringing about these welfare gains, and that any policy or practice that affects this foundation deserves as much attention as the content of the scientific research itself.

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[44] The "outsiders" may also be members of the commons, only acting in a commercial capacity. It is typical in university research circles for academic researchers to have commercial affiliations. I assume here that community members "role differentiate" in their dealings with each other, that is, behave differently in a transaction with the same partner when that partner is acting in a different role (e.g., commercial entity rather than academic colleague).