Mitigating 'anticommons' harms to research in science and technology

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Mitigating "Anticommons" Harms to Research In Science and Technology

New Moves in "Legal Jujitsu" against Adverse Consequences of the Exploitation of IPR on Publicly and Privately Funded Research Results

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ABSTRACT

There are three analytically distinct layers of the phenomenon that has been labeled "the anticommons" and indicted as a potential impediment to innovation resulting from patenting and enforcement of IPR obtained on academic research results. This paper distinguishes among "search costs", "transactions costs", and "multiple marginalization" effects in the pricing of licenses for commercial use of IP, and examines the distinctive resource allocation problems arising from each when exclusion rights over research inputs are distributed among independent owners. Where information use-rights are gross complements (either in production or consumption), multiple marginalization—seen here to be the core of the "anticommons" – is likely to result in extreme forms of "royalty stacking" that can pose serious impediments to R&D projects. The practical consequences, particularly for exploratory scientific research (contrasted with commercially-oriented R&D) are seen from a heuristic analysis of the effects of distributed ownership of scientific and technical database rights. A case is presented for the contractual construction of "research resource commons" designed as efficient IPR pools, as the preferable response to the anticommons.

Keywords: anticommons, R&D, multiple marginalization, IPR licensing, patent hold-ups, royalty stacking, distributed scientific databases, copyright collections societies, contractual commons

JEL Classification Codes: L24, O31, O34, O38

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Introduction and Overview

Most of the discussion and debate among legal scholars and economists concerning the so-called 'anticommons' has been restricted to questions about the existence and seriousness of the obstacles to discovery, invention and innovation that Heller and Eisenberg[1] suggested could result from "over-patenting" in the biomedical research area. But the anticommons, as a conceptualization of the perverse resource allocation effects of the distribution of private ownership rights, has a considerably wider potential range of empirical relevance, and warrants commensurately more careful study. This article underscores that analytical point, first by considering a stylized model of the impediments imposed upon the conduct of research by the burdensome licensing charges that arise from the dispersed distribution of ownership rights in a multiplicity of research tools that are complementary.

To make more transparent the generic character of the argument, the exposition in this heuristic analysis will focus on multiple database resources as the "research tools" of interest, individual access rights to each of which are held by different IP right owners. Adopting that approach both recognizes the emergence and growing role of digital databases as critical facilities of the research infrastructure in many scientific and technical domains, and serves to demonstrate the generality of the phenomenon of "multiple marginalization" that emerges from the uncoordinated exercise of market power by individual rent-seeking rights-holders in setting licensing charges on their intellectual property rights. .

Having briefly examined the relationship between that "core" phenomenon and other parts of the "anatomy of the anticommons," I turn next to consider whether market processes themselves could not correct the pathology. This part of the discussion briefly exposes several serious limitations of what may be viewed as the likely "spontaneous," profit-driven institutional responses that could emerge to mitigate the anticommons – in imitation of the private copyright clearance agencies and music performance rights collection societies. As it is unreasonable to expect that effective remedial developments of that kind will be forthcoming, there is a stronger case for pursuing new policies that would promote the "contractual construction" of scientific research commons, by common-use licensing agreements among the owners of IP arising from publicly funded scientific projects. This 'bottom-up' approach offers a path toward more far-reaching institutional changes that would mitigate some of the unintended consequences of the spread of efforts to claim and exploit intellectual property rights based upon publicly funded university research results.

Understanding the "anticommons" – a brief anatomical tour

[1] M.A. Heller and R.S. Eisenberg, "Can Patents Deter Innovation? The Anticommons in Biomedical Research" *Science,* 280, 1998: pp. 698 ff.

There are three analytically distinct layers of the troublesome object that has been labeled "the anticommons." Each layer is associated with a different kind of problem that may arise from the distribution of perfect exclusion rights over resources, rights of the sort that are conveyed by legal property ownership – and by intellectual property monopolies in particular. Searching to locate the owners of relevant rights, negotiating with those rights owners from whom access rights are needed, and paying the pecuniary charges for the licenses that are granted, are the three layered activities and each may impose costly burdens on enterprises that require access to the use of such assets when they are both numerous and in the hands of many other parties.

It is important to distinguish among these potential sources of costs for scientific and technological research enterprises in which legally protected property rights restrict access to the use of required informational resources that represent "inputs". Their economic implications are differently affected by the structure of productive relationships among the resources that enter into the research process, and particularly by the degree of technical complementary among various "research assets" that fall under the control of diverse owners of exclusion rights (such as are conveyed by IPR ownership). Furthermore, dealing separately with these parts of the anatomy of the anticommons acknowledges that such inefficiencies in the allocation of research resource as they would occasion may differ in seriousness, be amenable in different degrees to market solutions, or, failing that, require distinctive institutional remedies.

We may start "peeling the onion" of the anticommons with most immediately accessible layer, s*earch costs.* These are entailed in order to determine whether particular "tools" described in the scientific research literature – such as databases, or fast algorithms for mass spectrographic analysis, or specific biotechnology techniques (enzyme restriction methods, polymerase chain reaction, monoclonal antibodies, and others that are less well known) – are in the public domain or under patents, and if so who owns the rights to use them. The necessary searches that projects might conduct can be time consuming, and the mount in cost when many such tools are needed and the rights to use each of them can be in the hands of different owners. Similarly, finding all the specialized annotated databases containing the chromosomal locations of genetic mutations, or extended series of satellite images showing the locations and durations of plankton blooms and other oceanographic phenomena, and identifying whether each map or image is available in the public domain, or under copyright protections owned by various parties, would be quite burdensome when they are not collected and made available by a single licensing intermediary.

The *transactions costs* constitute the next layer and are distinct from search costs, because they arise only after one has identified the owner(s) of the IPR and begun to seek a license, or an agreement to transfer materials. Under the heading of transaction costs belong the time spent by lawyers or other negotiating agents – including the interested researchers who may need to personally contact members of other research groups at a firm or university that holds the IPR; they may have to work out a research collaboration as a way of arranging for cross-licensing, to gain access data or techniques or transfers of materials between laboratories.

The "transactions costs" aspects of the anticommons problem received particular emphasis in the testimony gathered during 1997-98 Tools from 29 biomedical firms and 32 academic institutions by the NIH Working Group on Research, according to Eisenberg's analysis of that testimony[2]:

[2] R.S. Eisenberg, "Bargaining over the Transfer of Proprietary Research Tools: Is This market Failing or Emerging?" in R. Dreyfuss, D.L. Zimmerman and H. First (eds.), *Expanding the Boundaries of Intellectual Property,* New York: Oxford University Press, 2001.

> "The exchange of research tools with the biomedical research community often involves vexing and protracted negotiations over terms and value. Although owners and users of research tools usually mange to work out their differences when the transactions matter greatly to both sides, difficult negotiations often cause delays in research and sometimes lead to the abandonment of research plans ….The result has been burdensome and frustrating case by case negotiations over exchanges that in an earlier era might have occurred between scientists without formal legal agreements.
>
> "….The foregoing discussion suggests some features of a market for intellectual property that may impede agreement upon terms of exchange, including high transactions costs relative to likely gains for exchange, participation of heterogeneous institutions with different missions, complex and conflicting agendas of different agents within these institutions, and difficulties in evaluating present and future intellectual property rights when profits are speculative and remote."

If a number of research tools and inputs are required, the sunk costs for each agreement that is negotiated may yield little of value to the project if they are strict complements of another "tool" for which no access agreement can be concluded. "Hold-ups" occur when owners refuse to deal, or wait until all the other properties have been assemble and seek to extract all the available "rent" in exchange for completing the tool-package. When the components of the package are in many hands, the risks of this rise, since it is more difficult to determine the likelihood that one of the IPR owners –for one is all it takes—will behave in this strategic matter. In some sense, the latter amounts to a second order search cost problem. Search and transactions costs, as they have been defined here, are incurred before any deals can be concluded, and it should be acknowledged that specialized intermediaries could undertake to carry out the search and transaction negotiations. Economies of scale and scope, and free entry into that business therefore would work to contain these costs even as the number of parties increased.

Yet, where entry can is blocked by monopoly rights to the use of inventions, as can occur when there are critical patents on research tool, the "hold-up" problem takes an exacerbated form. Lemley and Shaprio's analysis of "patent holdups" demonstrates that in a bargaining setting the threat to obtain a permanent injunction, preventing a perceived infringer from using the patent can be expect to greatly enhances the patent holder's negotiating power, leading to licensing agreements at royalty rates that exceed a natural benchmark range based on the value of the patented technology and the patent's strength. [3]

"Royalty staking" refers to the fact that what may be small royalty charges on each of a number of separately protected items of intellectual property, (whether patents or copyrights) can "stack up" to collective a significantly high cost on the product or service that requires their use. The circumstances in which this is likely to occur involve intellectual property, or other privately held resources the ownership of which is distributed. When, those elements are strongly complementary in use, this creates the core anticommons phenomenon that has the potential to critically burden research and innovation projects – namely, the effect on the price of access to the entire bundle of tools (or component inputs of a multi-element system) when royalties are set separately by the owners of each of the constituent elements in the bundle.

[3] M.A. Lemley and C. Shapiro, "Patent Hold-up and Royalty-Stacking" *Texas Law Review,* 85, 2007: pp. 1991 ff. [Available at: http://faculty.haas.berkeley.edu/Shapiro (last accessed October 26, 2010).]

The source of the problem of royalty-stacking is not simply that there are number element, for each of which a fee is demanded, but that the elements forming the bundle of access rights required by the user are each held by a different owner, and the owners do not act in concert when setting their royalty rate. Instead, they in effect ignore the effects of the royalties the other owners will be trying to extract from the same user. To restate this key point in slightly different terms, the distribution of exclusion rights to multiple items means that they may be priced in a way that disregards the negative pecuniary externalities of raising the price on any single item. The form of royalty stacking referred to as "multi-marginalization" severely compounds the patent hold-up problem (and IPR hold-ups more generally, as will be seen) when the constituent elements of a system are not substitutes for each another. Consequently, when a collection of research tools and information resources are gross complements, such that the incremental benefit of any one of them to the user is increased by using more of the others, and the IPR controls on access to the use of each are held by different owners, the resulting inefficiency in resource allocation will be the dual of the inefficiency that results when goods subject to congestions externalities are left in the public domain.

This duality has been shown to exist analytically by Buchanan and Yoon[4], who responded to the challenge in Heller's original paper on "The Tragedy of the Anticommons."[5] Heller had remarked that there was no formal analysis that proved his intuition that dispersed property rights might impede the workings of markets. Buchanan and Yoon set up a simple model in which the pricing of strictly complementary components by their owners ignores the negative income effects (pecuniary externalities) that their supply price would have upon the demand for the project as a whole. The combined effect of all the vendors' independent decisions is found to be to so raise the price of each item in the bundle of commodities that the quantity demanded of the entire bundle will be driven not only below the efficient use level that would obtain if every item was priced at its marginal cost, but lower than what would result if a single monopolist held all the items and priced them to maximized her profits on the whole lot.

Although there has been much discussion regarding the seriousness in practice of the "anticommons problem" as an inhibitor of commercial innovation, a considerable body of empirical evidence has accumulated which shows that royalty staking and multiple-marginalization of complementary good (use rights subject to IP protections) are not merely theoretical possibilities but actual problems in certain branches of industry and in biomedical science. Most of this positive evidence pertains to situations where many patents read on the same product, as Lemely and Shapiro have illustrated using cases involving software patents in the fields of third generation cellular telephones and WiFi, where royalty staking exacerbated patent hold-p and further problems in standard-setting contexts where hundreds or even thousands of patents read on a single product standard.

Ziedonis has provided systematic econometric evidence of royalty stacking in the U.S. semiconductor industry,[6] and Noel and Schankerman make a parallel case for its presence in the software industry.[7] There have been conflicting views on the question of whether there actually

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[4] See J.M. Buchanan and Y.J. Yoon, "Symmetric Tragedies: Commons and Anticommons" *Journal of Law and Economics,* 43(1), 2000: pp. 1-2.

[5] M.A. Heller, "The Tragedy of the Anticommons: Property in the Transition from Marx to Markets" *Harvard Law Rev.*, 111, 1998: pp. 621 ff.

[6] R.H. Ziedonis, "Don't Fence Me In: Fragmented Markets for Technology and the Patent Acquisition Strategies of Firms" (2004) 50 *Management Science* 804.

[7] M. Noel and M. Schankerman, "Strategic Patenting and Software Innovation," Center for Economic Policy Research Discussion Paper No. 5701, London School of Economics, 2006.

are anticommons effects on biomedical innovation arising from the patenting of research tools in the biomedical sciences, as Eisenberg and Nelson have argued.[8] Schaft's[9] discussion of the role of patents in biomedical research, as well as in the software industry, are specific in pointing out the dangers of royalty stacking in those areas, but whether these result in clear-cut anticommons impediments to biomedical innovations is another matter. Walsh, Arora, and Cohen reported that interviews with industry researchers revealed they deployed a variety of ways to work around patents on research tools, including licensing, "inventing around", and outright infringement.[10] A set of parallel interviews with university scientists found no striking instances of basic biomedical research projects having been stifled by patents on biomedical research tools.

Yet, the latter was the case in significant part because the interviewees had simply ignored the patents that would pose inconvenient obstacles. Further, as David has pointed out,[11] Walsh, Arora and Cohen's search for instances in which researchers simply abandoned ongoing projects when they found themselves blocked by the costs of obtaining patent licenses for key tools is an unrealistically extreme a test of the anticommons hypothesis; it presupposes that the problem could not be foreseen in the research planning stage, well before funding was sought or research actually got underway. Were it foreseen those researcher who were not prepared to simply ignore obstructing patents, would be more likely to have modified their research design, or alter the objectives of the project so as to avoid the foreseen intractably obstacles to obtaining required research tools.

Murray and Stern, however, by studying scientific papers that are paired with associated U.S. patents, find evidence suggesting the there are modest anticommons effects on the exploitation in applied research of the results of fundamental research findings that provided novel research tools; following the granting of patents on inventions described in previously published journal articles, the frequency of scientific citations to those papers undergoes a significant decrease.[12] In biomedical services, as distinct from research activities, genetic testing is a branch of the health care industry where royalty-staking clearly has been identified as a problem, as the report by Walsh, Cho and Cohen has noticed.[13] In the case of diagnostic kit patents, especially the Myriad patents on the tests for heritable breast cancer, the effects on the price of suites of tests each of which is patented has been to push the costs of "bundled tests" so high as to curtail the demand, with the result that the number of labs offering these testing services has decreased. This has brought some negative externalities in the form of a slowing of research to improvement the tests diagnostic accuracy. Undesirable as that is, it does not constitute a research anticommons problem per se, because it arises (downstream) in a final service industry. Nevertheless, it remains to be seen whether or not there are upstream developments in genetic testing that are being blocked by the unwillingness of patent-holders who commercially supply these high-priced services to license the basic research tools that are need to create new tests.

[8] R.S. Eisenberg and R.R. Nelson, "Public vs. Proprietary Science: A Fruitful Tension?" *Daedelus,* 131(2), 2002: pp. 89ff.

[9] Wendy H. Schacht, *Patent Reform: Issues in the Biomedical and Software Industries*, Congressional Research Service Report for Congress (Washington, D.C.: 2006).

[10] J.P. Walsh, A. Arora and W.M. Cohen, "Working Through the Patent Problem," *Science,* 299, 2003: pp. 1021 ff.

[11] P.A. David, "The Economic Logic of 'Open Science' and the Balance between Private Property Rights and the Public Domain in Scientific Data and Information: A Primer" in J. Esanu and P.F. Uhlir (eds.), *The Role of the Public Domain in Scientific Data and Information: A National Research Council Symposium.* Washington, D.C.: Academy Press, 2003.

[12] F. Murray and S. Stern, "Do Formal Intellectual Property Rights Hinder the Free Flow of Scientific Knowledge? An Empirical Test of the anti-Commons Hypothesis." *Journal of Economic Behavior and Organization*, Vol. 63(4), 2007: pp.648-687.

[13] J.P. Walsh, C. Cho and W.M. Cohen, *Patents, Material Transfers and Access to Research Inputs in Biomedical Research* (Final Report to the National Academy of Sciences' Committee on Intellectual Property rights in Genomic and Protein-Related Inventions, National Academy of Sciences, Washington, D.C., September 20, 2005).

The generalized "research data anticommons" – a heuristic model

For convenience in showing the symmetry between the exhaustion of the value of a finite resource that is over-used, because there are no exclusion rights in the hands of any of the potential users of a tangible resource, and loss of the value of a bundled of resource whose differentiated but complementary parts are owned by so many monopolists that a resulting high-priced bundle as a whole remains unutilized, Buchanan and Yoon construct an artificial case: a physical space that can be used as an urban parking lot.[14] Under one regime access to the spaces are unrestricted (and un-priced), and the lot is completely congested, so that its value to those needing to park is destroyed. In the other case, to occupy any space requires purchasing many types of (differently colored) tickets, one from each of many different exclusive owners of tickets of a distinct color. The price of the effective permission to park would rise until nobody would use the spaces, and the value of the resource thereby is destroyed.

The connection between the effects on scientific research of the distribution of IPR, and this formal analysis of the anticommons is perhaps a little too strained to effectively convey the generality and the implications of "multiple marginalization" for the allocation of resources among research projects of different kinds. Multiple-marginalization should be seen not only as potentially impeding the use of patented or copyrighted research tools, and thereby blocking some research projects, but, more generally, as degrading the exploration of large data-fields – or "discovery spaces" formed by the federation of databases – which have become particularly important
in many exploratory research domains.

To fix ideas here, one can take as a concrete example, the haplotype map, or "HapMap" as an emblematic a database tool that has been created by the National Human Genome Research Institute (NHGRI) and other national funding agencies when they undertook the International Haplotype Mapping Project in 2002.[15] The scientific purpose was to allow biomedical researchers to find genes and genetic variations that affect health and disease. The DNA sequence of any two people is 99.9 percent identical, but the variations may greatly affect an individual's disease risk. Sites in the DNA sequence where individuals differ at a single DNA base are called single nucleotide polymorphisms (SNPs – referred to colloquially as "snips"). Sets of nearby SNPs—on the same chromosome—are inherited in blocks; the pattern of SNPs on a block is called a haplotype. Blocks may contain a large number of SNPs, yet a few SNPs are enough to uniquely identify the haplotypes in a block. The HapMap is a map of these haplotype blocks and the specific SNPs that identify the haplotypes are called "tag SNPs". By reducing number of SNPs required to examine the entire genome for association with a phenotype—from the 10 million SNPs that exist down to roughly 500,000 tag SNPs – the HapMap provides a means of greatly reducing the costs and effectiveness of research in the field of genetic medicine. By dispensing with the need for typing more SNPs than the necessary tag SNPS, it raises the efficiency and comprehensiveness of genome scan approaches to finding regions with genes that affect diseases.

One may then imagine the situation of distributed exclusion rights that could arise from the independent patenting of tagged sequences by separate research groups, working in different

[14] Buchanan and Yoon, "Symmetric Tragedies: Commons and Anticommons," *Journal of Law and Economics*, 43(1), 2000.

[15] See http://www.genome.gov/10001688 [Accessed November 8, 2010].

universities and firms. But, even supposing that the SNPs individually were left in the public domain, multiple owners of rights to exclude researchers from searching for particular “tag SNPs” could arise where legal protections were afforded to database owners who had made an investment in assembling the contents. Deep-linking and database federation can be impeded by the legal protection of database rights afforded by national legislation conforming to the EU’s 1996 Directive on the Legal Protection of Data Base Rights, as these apply to both copyrighted materials or materials that are not copyrightable. Access costs charged by each collection of “tag SNPs” would then tend to impede the research use of extensive “discovery spaces” for exploratory research in genomics, proteinomics and related epidemiological data, even where owners were prepared to license extracting content from them.[16]

To examine this a little more formally, consider a simple model of a research production project: the output is results, R, produced under cost-minimizing conditions on a budget of G $G = \sum \left[p\{i\} \right] \left[b\{i\} \right] + X,$ according to the production function $R = F(S, X),$ where X is a vector of inputs of experimental time and equipment and S is the output of a search activity, according to search function: $S = S\left(b\{1\}, b\{2\}, \ldots b\{B\}\right)$, in which b{i} is the information extracted from database i.

We may suppose that the search function, S, takes a special form described by a constant elasticity of substitution (CES) production function, in which the inputs b{i} enter symmetrically. The latter specification holds that there is parity among the databases in the respective intensities with which they are used in the search process, and is assumed here for expositional convenience. The same is true of the assumption of first-degree homogeneity, which abstracts from the possibility of their being either increasing or decreasing returns to scale in search. In other words, the informational output of the search process, S, will be doubled by doubling the amount of information extracted from each of the B databases that are examined.

Further, the specification of the search production function S allows for substitutions among material from different databases, indicating the ease of substitution by the elasticity of substitution parameter σ: σ= 0 then corresponds to the condition of strict complementarity in which no substitutions are possible and the materials to be extracted from the different databases would be in fixed proportions to one another, regardless of their relative prices; alternatively, σ= 1 corresponds to the (Cobb-Douglas) case in which a project’s cost-minimizing search will allocate invariant shares of its total search budget to each of the B databases, and, given the assumption of symmetry among them in the search production function, that implies the relative amounts of data from any pair of databases would vary inversely with the relative unit prices of the data to be extracted from each.

For expositional purposes we restrict this discussion of the model's implication to the case in which all research projects have identical search strategies, constrained by the same search technology, and the same form of derived demands for database contents. From the (common)

[16] See *IPR Aspects of Internet Collaborations*, EC/Community Research Working Paper, EUR 19456, April 2001, for the remarks on the importance of “discovery spaces” by Graham Cameron, Director of the European Bioinformatics Institute. In a meeting of the EC working party (on January 22, 2001) Cameron stated that to construct anything resembling the existing EBI federated database structure would be quite infeasible under the access restrictions that had come to prevail in the field of biogenetics, an observation discussed further by P.A. David, “Will Building ‘Good Fences’ Really Make ‘Good Neighbors’ in Science?: Digital Technologies, Collaborative Research on the Internet and the EC’s Push for Protection of Intellectual Property,” *Ibid.*

CES production function for "search" one obtains these derived demands for access to database contents for each project, as a function of unit extraction charges, the project's real budget level and the elasticity of substitution among the B databases. Assuming database owners have legal monopoly rights and set profit-maximizing royalty rates for data extraction independently (as discriminating monopolists would do), one may solve for the resulting relative prices that will emerge as the Nash solution from the interactions of the effects of their price-setting on the projects' respective derived demand schedules for the contents of the available set of databases. The resulting prices then determine each project's consequent cost-minimizing search, and, given its budget constraint, the informational output that will enter its research production and thereby affect its research output.

The basic qualitative features of the results that have been discussed in the context of the simpler Buchanan-Yoon[17] model turn out to hold also in this more general setting. Even if the b{i} are not strict complements, and there are symmetrical non-zero pairwise elasticities of substitution among them, when database rights are separately owned and priced independently to maximize the owners' separate revenues one finds that the larger is the number of required databases (B), the more severely degraded will be S. Hence R (research output) for given funding levels will be reduced – so long as S and X are not infinitely substitutable. Of course, the lower is the elasticity of substitution among the different database inputs in the search activity, the more marked would be the adverse income effects of the mark-ups charged by database monopolists on the overall research project's output, given its fixed budget constraint.

Where the elasticity of substitution between the search activity and other inputs is unitary the effects of the independent pricing strategies of the data-base owners translate into degraded search output, against with there may be offsetting increases in the intensity of other inputs. The outcome from an economic welfare efficiency viewpoint in this case, as in the standard multiple-marginalization analysis, can be shown to be inferior to that which would obtain under joint monopoly ownership of rights to the required (database) inputs.

The foregoing results may be interpreted to support the intuitive notion that the incidence of the anticommons problem will fall particularly heavily upon exploratory science, such as that in bioinformatics where large discovery spaces comprising many (federated) databases are needs. But the same would hold also for design fields such as advanced computer software, where many libraries may be searched for modular algorithms that have been found to interoperate in unproblematic ways with an existing code base. By contrast, narrowly focused searches, say, for particular targets in a SNPs database, might be less impacted. Moreover, commercially oriented R&D projects in which the "research" portion of the budget is small in relation to the development costs, would be far less likely to be adversely affected because even if it is not possible to substitute D for R, the impact of the elevated search costs on R will scarcely be noticeable in the overall costs of the innovation.

Perhaps the most interesting implications of this generalized model of "multiple marginalization" in the market for legally protected scientific research data are those concerning the differential incidence of the search-degradation on exploratory research, by comparison with focused commercial applications-oriented R&D. This points to the need for a more nuanced approach in empirical efforts to assess the ways in which this and other cost-imposing dimensions of the anticommons problem would manifest themselves. Reconsidered from that angle, the conclusions drawn from the questions posed to academic researchers by the pioneering survey- and interview-based studies of the impact of patented research tools in the biomedical

[17] Buchanan and Yoon, "Symmetric Tragedies: Commons and Anticommons," *Journal of Law and Economics* 43(1), 2000.

area seem to be overly sanguine, in supposing that the existence of a "serious anticommons" effect would take the form of the blocking or abandonment of ongoing research projects. That such events are reported to be "as rare as the White Tiger," will be seen not to be surprising,[18] and consistent with the existence of more subtle but cumulatively distorting long term effects on the advance of fundamental science -- upon which the ability to sustain high rates of innovation will be based. Of course, the apparent readiness on the part of the academic biomedical researchers who were surveyed to simply ignore the question of whether they might be infringing patented tools also could account for the rarity with which they reported that their research projects were actually blocked by "patent thickets".

The limits of spontaneous order: anticommons ills that markets can and cannot cure

Before moving to the conclusion that protection of exploratory scientific research requires special measures to counteract the potential harms from anticommons effects, especially where database protections compound the effects of patent laws, it is proper to us to inquire whether the problems created by the distribution of IP ownership cannot be solved by the same means. That question can be treated in two specific connections, considering first the idea that the existence of transferable rights would allow the problems of search and negotiation costs to be mitigated by the development of institutionalized solutions modeled on copyright collection societies, and second, that these might also be a palliative for the "royalty stacking" created by uncoordinated pricing of bundles of patents that constitute "thickets."

The second connection is simply a more general formulation of the latter claim—namely that owners of complementary intellectual property rights may well have private profit-incentives to exploit those rights in a collectively managed "pool," and therefore could act spontaneously to mitigate the worst inefficiencies of multiple-marginalization. But the proposed copyright collecting society-like mechanisms on closer inspection turn out to be inadequate to deal with the core source of the inefficiency arising from distributed exclusion rights to complementary research assets that are protected by patents or by technical means such as encryption in digital rights managements system.[19]

Why can't private "intermediating" organizations emerge and profit by providing a market solution for scientists' anticommons problems? The answer is that the proposal to encourage the organization of profit-oriented collections societies is based upon an inadequate analogy with the problems in music copyrights and performance rights that induced the formation of such institutions. This "solution" aims to reduce costs of search and transacting, and lower the costs of rights enforcement, by using economies of scale and scope in search, and reutilizing the information in repeated licensing transactions. By making the use of IPR less costly, collecting societies could actually encourage greater research production—by inducing widespread patenting of research tools. In addition, the collections society has an incentive to write contractual provisions (e.g., grant backs), in order to induce non-cooperating owners to share use of their exploitation right in exchange for royalties. While accomplishing all that does sound like a good thing, it may be too good to be realistic. There are quite a number of reasons why private

[18] P.A. David, "The Economic Logic of 'Open Science' and the Balance between private Property Rights and the Public Domain in Scientific Data and Information: A Primer," in *The Role of the Public Domain in Scientific and Technical Data and Information: A National Research Council Symposium*, J. Esanu and P.F. Uhlir, eds., Washington, D.C.: Academy Press, 2003 [Available as SIEPR Discussion Paper 02-03, at: http://siepr.stanford.edu/publicationsprofile/445].

[19] This draws upon the argument made by Michael Spence in a 2006 comment, (privately communicated) and subsequently published in M. Spence, "Clearing House Mechanisms: Conceptual Framework: Comment on a Paper by Esther Van Zimmerman" in G. Van Overwalle, ed., *Gene Patents and Clearing Models,* Cambridge University Press, 2009.

"intermediating" institutions are not the best, or even the second-best solution for scientists' anticommons problems.

First, there are likely to be feasibility and cost problems with the generic "collections society solution" that don't cause comparable difficulties with the copyright collecting organizations because they deal with a form of IP that is very different from the contents of patents, and database rights:

- Copyright authors typically want their products distributed widely, but this is not so generally the case with patents.
- Copyrights in songs, in texts and even images are more likely to be substitutes than is the case with patents, and scientific data.
- Copyright collections societies target specific use-markets, but uses of research tools are much wider and more difficult to predict, so pricing decisions are more difficult.

Secondly, while there most likely would be cost-savings in patent searches and the location of specialized scientific databases, and in identifying the rights-holders who will grant non-exclusive licenses, it is possible that the consequences of these could be perverse. Spence points out that by making the use of IPR easier for universities and other public research organizations, a collections society approach could also encourage strategic uses of licensing terms that would disadvantage rival research projects, or encumber researchers in rival institutions.[20] The view that universities would not behave that way seems overly sanguine in ignoring the competitive pressures under which many of these institutions are operating today. Some U.S. universities holding biomedical patents have not been hesitant to write letters pointing out infringements, and requesting that the letter-recipients apply for licenses. In the UK several universities have been drawn into conflicts with one another over competing claims to the same database that, in various stages of its development, was hosted on their websites by a researcher who career exhibited the mobility one might expect of a talented contributor to the biogenetics literature.[21]

Next, one has to ask whether there will be an improvement on the existing situation in the public sector—where, according to Walsh, Arora and Cohen, academic biomedical researchers say they just ignore patents.[22] Compared to the state of non-compliance and non-enforcement, collections societies could make things much worse from the viewpoint of public research productivity—while improving compliance with the law. There is a trade-off here, but some might argue that the most effective way to remove a bad law is to enforce it vigorously.

Fourthly, and by no means least in significance, the historical record of the music copyright and performance right collections societies reveals a potential for abuse of market position.[23]

[20] See Spence (2009).

[21] See, e.g., the case of the "PRINTS" database, related by T.K. Attwood "Mobile, Metamorphosing Academic Databases – Capturing IP on the Move" in *Workshop Report on Managing IPR in knowledge-based economy- Bioinformatics and the influence of public policy.* European Commission DG Research – Fifth Framework Programme, 2001. For comments on this instance of ambiguous ownership of a database created by an institutionally mobile research scientist, see P.A. David and M. Spence, "Towards Institutional Infrastructures for e-Science: The Scope of the Challenges," *A Report to the Joint Information Systems Committee of the Research Councils of Great Britain,* Oxford Internet Institute Report No. 2 September 2003 [Available at: http://www.oii.ox.ac.uk/resources/publications/OIIRR_E-Science_0903.pdf]: p.42 and Appendix 5.

[22] J. Walsh, A. Arora and W. Cohen, "Working Through the Patent Problem" *Science,* 299, 2003:pp.1021 ff.

[23] See, e.g. M. A. Einhorn, "Transactions Costs and Administered Markets: License Contracts for Music Performance Rights," *Review of Economic Research on Copyright Issues*, 3(1) 2006: pp.61-74.

Bundling of wanted and unwanted licenses is an attractive strategy for the society, so competition authority supervision would be needed on that score, as well as on grounds that the interests of members of those societies shift in the course of their development toward attempting to exclude variant content that could be substituted for that of the existing rights holders. It may well be the case, however, that the existence of more than one cluster of complementary research tools is a reflection of the useful adaptation of tool-sets to variant problems that are specific to different research domains, or to special research environments. Forcing users to pay for redundant alternatives is an abuse, but so is denying them access to alternatives that are not always redundant in order to raise the rent that can be extracted from those that are provided. True, the collecting societies in the field of music performance rights are restrained from excessive pricing by the adverse effects on revenue, but that is in large part because other copyright material are available as substitutes. This condition is less usual in the case of patents, and, especially when some patents in the bundle that were complements, there may be unjustifiably big markups.

The burden of this analysis therefore is that substantial doubt surrounds the wisdom of an implicit policy position that prefers letting "anticommons problems" be remedied by the workings of new institutions engendered by forces in the markets for valuable intellectual property. Thus, some positive policy action would appear to be called for, particularly in view of the distribution of IP rights to exploit research results arising from publicly funded R&D projects that is being produced by the workings of the Bayh-Dole Act of 1980 in the United States, and kindred legislative and administrative measures introduced in the EU and elsewhere. The proposals in the following section offer a preliminary response to that challenge.

Common-use contracting in IPRs -- clearing pathways through some "mental thickets"

A discussion of suitable policy measures would aim to (1) clarify the meaning and practical significance of the idea of legally creating an "information common" for scientific and technical research communities by means of common-use contracting, (2) inquire into the conditions under which these are likely to emerge spontaneously as "clubs" or "pools" among holders of IPR in research tools and databases, rather than having to be pro-actively encourage by public agencies, and (3) consider specific policy measures that would be appropriate and effective in promoting participation of universities and other public research organizations in IPR licensing arrangements of that kind. It is possible on this occasion only to touch upon some of the salient points under each of those headings.

To make space for the "commons solution" one needs to clear away economists and lawyers' misconceptions about "the commons," and stop textbook repetitions of the travesty of the 'Tragedy', like this one:

> "The *anticommons* is a play on words and refers to the 'tragedy of the commons' which is taught in freshman economics. In the tragedy of the commons peasants in early modern Britain overgrazed shared pastures ('the commons') because the absence of private property eliminated incentives to conserve."[24]

The historical reality is totally different. Contrary to the historical fantasy of a "common pool problem" promulgated in the influential essay by Garrett Hardin,[25] this "tragedy" never was:

[24] S. Scotchmer, *Innovation and Incentives*, Cambridge MA, The MIT Press, (2004) p.88.

[25] Garrett Hardin, "The Tragedy of the Commons" *Science,* 162, 1968: pp. 1243 ff.

from the 13th century onwards, the records of Europe's agrarian communes detail regulations adopted "by common consent" of the villeins (tenants) to control the exercise of rights of common grazing on the fallow fields, the meadows, and the stubble-fields (the postharvest grain-fields) of the village's arable land. Internal management accompanied exclusion of strangers. Ostrom's,[26] and subsequent works on "common property resources," have shown the relevance of this to real resource problems in developing economies. Studies of the historical experience of successfully managed common property resources document this abundantly. For example, by the 'early modern era' in Britain, and equally in the more densely settle arable farming regions of northern Europe, the management of common grazing rights prescribed *stinting*: tenants in the village were allocated "stints" that specified the numbers of specific animals that commoners could put on the fallow or common pasture lands, apportioning these rights in relation to the size of their holdings in the arable field, and sometimes in the meadowland.

The Commons in tangible exhaustible resources is not a defunct institution, for collective ownership of exhaustible resources did not, and does not translate automatically into a chaotic struggle for possession among neighbors, nor does it result in the egalitarian distribution of use-rights. Even in western Europe today, such arrangements based upon *de jure* common use rights (*res communas*) dating from the Middle Ages have survived in the Swiss Alps and Northern Italy —e.g., the Magnifica Comunità di Fiemme, in the valley of Aviso (Trento)—where they still govern the use of tens of thousands of hectares of alpine forests, pasture and meadow land. Moreover, a growing number of contemporary empirical studies in the developing world—following Ostrom —also are showing how common pool resources can be managed successfully under a variety of common property regimes.

Selective implementation of common-use contracting: efficient IPR pooling agreements

The case for efficient patent pools[27] rests on overcoming the obstacles to research and innovation posed by the growth of "thickets" and designed complementarities in claims that create blocking patents. It is recognized that pooling creates a potential for anti-competitive behavior, notably the bundling together of essential strong and high-value patents with weak and inessential low value patents as a means of extracting greater royalty revenues. Consequently, some means of defusing generic antitrust objections to pooling would advance the case for efficient pooling.

An empirical procedure for establishing the likelihood that an inefficient patent cluster, i.e., a "thicket" had formed would go some way to addressing this issue, and it is therefore is relevant to notice Clarkson's proposal and practical demonstration of the a method of using network analysis to discover patent thickets and disqualify them as ineligible for efficient pool status.[28] Nevertheless, dual pricing policies by foundations running PRC-i's, would be potentially subject to abuse, and competition among those proposed foundations will be quite limited if they are successful in internalizing complementarities. Therefore, that there would be a need for continuing monitoring of the PRC-i foundations and vigorous anti-trust supervision seems an inescapable conclusion.

[26] See, e.g., E. Ostrom, *Governing the Commons: The Evolution of Institutions for Collective Action*, New York: Cambridge University Press, (199); E. Ostrom, J.S. Walker, and R. Gardner, *Rules, Games and Common-Pool Resources,* Ann Arbor: University of Michigan Press, 1994.

[27] See e.g., J. Lerner and J. Tirole, "Efficient Patent Pools," *American Economic Review,* 94(2) June 2004: pp 691-711.

[28] G. Clarkson, "Objective Identification of Patent Thickets", *Harvard Business School Working Paper*, version 3.9. 2004.

To create “research commons” by common-use licensing of intellectual property is not an unprecedented idea, however. Indeed, it has been gaining adherents recently in a variety of practical forms. Free and Open Source Software (FOSS) is by now a familiar approach to ensuring access to software tools, using copyright licensing terms: GNU GPL (‘copyleft’ principle) requires distributors of code to do so on the same open source, royalty free, attribution basis on which they received the code, providing contributors of software licensed in this way with the prospective benefits of having reciprocal access to the code that other will build upon it. Less well known than FOSS, Science Common[29] was launched under the aegis of Creative Commons in 2005, with the goal of bringing to the world of scientific endeavors the benefits of openness and sharing the goal of bringing the openness and sharing that have made Creative Commons licenses a success in the arts and cultural fields. Its projects enlist its own technical and legal experts, and mobilize others to designs strategies and tools for faster, more efficient Web-enabled scientific research—through common use licensing of data contributed to repositories, cross-licensing of patented research tools, pre-commitment to standard materials transfer licensing on RAND terms.

Science Common’s Neurocommons Project,[30] collaboration between Science Commons and the Teranode Corporation, is building on open access scientific information and data – content that is digital, online, free of charge, and free of most copyright and licensing restrictions—to build a semantic web for neuroscience research. A semantic web can be conceptualized as a graph or network of connections among distinct bodies of information and/or data that is grounded on a set of common standards to describe and name the relationships that are contemplated and described in text: relational statements in the life sciences might take forms such as “this gene is active in this disease”, “is related to this protein”, “which is folded in this way”, etc. Using the standard allows one to republish content of this kind in a format that researchers can use software (running search engines, browsers, statistical analysis) to search, evaluate, form new links and integrate with content in other specialized knowledge domains. This initiative aims to create an efficiently usable, managed, open access commons that will empower neuroscience researchers, and to create a demonstration model of the way this can be done that will be portable, and thus help to transform other complex fields of research activity.

Other “commons-like” initiatives provide public domain access to otherwise patentable material under licensing conditions that restrict users from appropriating the benefits by utilizing it to obtain IRP on new, commercially valuable research products, or, alternatively retain ownership but irrevocably allow other to freely use patents that are place in the commons but select those contributions to be those having applications in a particular desired sphere. Considering just two cases, first, the well established HapMap Project, and then the very recently formed and still experimental Eco-Patent Commons will be sufficient to exhibit the range of diversity in these promising developments.

HapMap project

The HapMap project followed the precedents established by the Human Genome Project[31] by rejecting protection of the data under copyright or database rights, and establishing a policy requiring participants to release individual genotype data to all the project members as soon as it

[29] See http://neurocommons.org/page/Main_Page [Accessed November 8, 2010].

[30] See http://neuroscience.org [Accessed November 8, 2010].

[31] HGP, see http://www.genome.gov/10001688 [Accessed November 8, 2010].

was identified. It was recognized that any of the teams with access to the database might be able to take that data and, by combining it with their own genotype data, generate sufficient information to file a patent on haplotypes whose phenotypic association with disease made them of medical interest. To prevent this, a temporary "click-wrap license" was created—the IHMP Public Access License—which does not assert copyright on the underlying data, but requires all who accessed the project database to agree not to file patents where they had relied in part on HapMap data.

The HapMap thus represents a special case of legal jujitsu, where a copyleft strategy has been mutually imposed on database users by an enforceable contract in the absence of IPR ownership. Technological protection of the database at a level sufficient to compel users to take the "click-wrap" license makes it possible to dispense with the legal protection of asserting copyright in order to use "copyleft" licenses.

Eco-Patent Commons

The Eco-Patent Commons, launched in January 2008 by IBM, Nokia, Pitney Bowes and Sony in partnership with the World Business Council for Sustainable Development, was founded on the commitment that anyone who wants to bring environmental benefits to market can use the patents that are contributed to the commons to protect the environment and enable collaboration between businesses that foster new innovations. This appears to be a response to the perception that technology transfers unencumbered by licensing restrictions and royalties will be an important mechanism in the diffusion of new technologies that can contributed to mitigation of climate change, and encourage downstream inventions that build upon or work in a complementary manner with those in the commons.

According it its website,[32] the objectives of this undertaking are "to provide an avenue by which innovations and solutions may be easily shared to accelerate and facilitate implementation to protect the environment and perhaps lead to further innovation", and "promote and encourage cooperation and collaboration between businesses that pledge patents and potential users to foster further joint innovations and the advancement and development of solutions that benefit the environment." Since its launch, 100 "eco-friendly patents have been pledged by 11 companies who retain ownership of their pledge patents, and bear the associated costs, but make the patents freely available for use by third parties.

An initial study of 92 of these pledged patents by Hall and Helmers[33] finds that the participating firms appear to be doing more or less what they claim, pledging valuable "green" patents (more valuable than the average patent in their respective portfolios), although about a fifth have expired, and a seventh have not yet issued. Because, under the regulations, third parties do not need to notify the owners of the pledged patents when they use them, it will be difficult to statistically evaluate the Eco-Patent Common's effectiveness in diffusing green technologies and stimulating upstream innovation by non-pledging firms, or for the pledging firms to quickly identify new technologies that are being built on the patents they contribute to the pool. It is too early to assess the success of this initiative but it demonstrates at least that there are contexts in which private corporations are prepared to act on the premise that they will benefit along with others by sharing resources that are building blocks for innovations that – as is the case with

[32] See http://www.wbcsd.org [Accessed November 8, 2010].

[33] B.H. Hall and C. Helmers, "Innovation in Clean/Green Technology: Can Patent Commons Help?" Discussion Paper presented at the EPIP Annual Meeting, Held in Maastricht, the Netherlands (September 20-22, 2010).

climate change mitigating technologies – have potential to yield large "public goods" spillovers.
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A summary of the argument, and where it leads us

This article has advanced the case for a particular approach to restoring a healthier balance between proprietary arrangements governing the commercial exploitation and private appropriation of research results, as an incentive mechanism to drive invention and innovation, and the provision of open data and information infrastructures that emulate features of the public domain that are particularly hospitable for and efficient in active and collaborate research aimed at increasing the stock of reliable scientific knowledge. National funding agencies should be urged to agree individually and jointly to exercise their authority over the conditions governing the use of public research funds in order to require that data created on such projects be placed in open repositories, and to impose common-use licensing of IPR in complementary research "tool sets". These agencies should set management rules for the irrevocable assignment of IPR to regulated "public research commons in information" (PRC-i) when such rights arise directly from projects that draw significant public funding.

The argument for this course of action has been developed here in seven steps, or propositions:

- **Prop. 1:**

  Scientific and technical research in the modern world entails the production of data and information (which are international public goods) by means of the same class of international public goods.

- **Prop. 2:**

  There are three pure types of institutional solutions—property, patronage and (public) provision—for the allocation problems in the production and distribution of information that arise from the latter's public goods properties.

- **Prop. 3:**

  Each of the "3 Ps" offers an imperfect solution, and most of the successful modern economies employ all of them in some degree, but the mixture has shifted towards property.

- **Prop. 4:**

  The "property solution" (IPR) creates legal monopoly rights to exploit the new information, and may improve the market allocation of resources in information production through the incentive effects; but commercial exploitation of the rights itself inhibits information use—and the "deadweight burden" that is incurred in scientific and technological research itself is likely to be particularly heavy for society.

- **Prop.5:**

  Information disclosed and left in the public domain enables the efficient growth of knowledge through the conduct of "open science" research, so long as (a) patronage is available and (b) "enclosures" of the public domain does not impede access to the research tools.

- **Prop.6:**

There are conditions under which IPR in research tools is particularly damaging to scientific progress, these have come to be referred to loosely as "the anticommons"—which needs to be precisely defined; in those conditions, "common-use" pooling of information resources is likely to be both socially more efficient, and a dominant strategy for researchers.

• **Prop.7:**

IPR owners can contractually construct "information commons" that emulate public domain conditions that will be sustainable against opportunistic "enclosure"; and in the case of a non-exhaustible resources (information), there is good reason not to exclude any contributor of IPR to the research commons—so long as the additions also are complements of the rights from which the existing PRC-i has been formed.

Some closing remarks are now in order, with regard to the political economy aspects of the proposed programme of ameliorative actions. The policy thrust of the argument that has been advance here may be seen as tantamount to (indirectly) reforming the workings of the Bayh-Dole and Stevenson-Wydler Acts in the United States and parallel legislative measures that were subsequently introduced in a number of OECD countries. It calls for the development of specific institutional arrangements for the administration of "scientific research commons" (SRCs) formed by IP right-holders that would need to address five key issues. These include:

- conditions of eligibility to participate
- limitations upon the scope of legally protected content that can be placed within the commons
- principles for the management and pricing of licenses granted to non- commoner for use of intellectual property rights contributed to, and arising from the utilization of pooled research assets relationships among independent SRCs and between SRCs formed by universities and other public sector research organizations that presently maintain technology licensing/transfer offices
- the implications of competition policy safe-guards against the creation of inefficient pools, and the abuse of patent cartel power.

The foregoing is in a sense a way to describe the features of the destination at which I advocate we should seek to arrive. What it does not indicate is whether this is a feasible route for making such a journey from where we now find ourselves. It surely is important to design a transformative process that has favorable transition dynamics. Thus, each commons would provide positive externalities to those who join, and those who are already participating, to the extent that the new use-rights are complements of those already in the pool. But in general these benefits will be more attractive to universities will small and less coherently structured IP portfolios, and offer less to the comparatively few institutions that have many patents and effective, well funded TLO operations.

On the other hand, the question is whether the immediate portfolio return consideration of those research universities and their TLO staffs will prevail over the interests of their researchers in pursuing fundamental scientific research un-encumbered by the need to overcome, or avoid obstacles created by the dispersed distribution of patent holding on research tools. In general it may be supposed that the interests of leading researchers that have a demonstrated capacity to gain public funding will weigh heavily with all but the most myopic and reckless university administrators. This is a hopeful notion, because it implies that even when influential academic scientists are prepared to simply ignore other institutions patents, public funding agencies could set conditions for grant recipients to pool patents on relevant tools that their institution owns with those held by other public grant recipients. This could be done a condition for eligibility to submit grant proposals, which would create a strong incentive for university compliance if they sought to retain the scientists that had promising trajectories of research in that field.

The problem with this approach, however, is that it is not clear that such researchers will be ubiquitously distributed among the research universities, so where they were not currently present, patent-holdings at those institutions could contain “unpooled” blocking patents. Across-the-board pooling requirements would address that defect, but at the expense of mobilizing opposition from all those with less to gain from securing their star researchers’ eligibility to compete for public research funding.

Another potential problem with bottom up coalition formation on behalf of the commons building goal concerns the interests of the university technology licensing professional that have become a potentially important lobbying force in the U.S., and may be emulated elsewhere. There will be winners and losers if the business now conducted in many small TLO’s is consolidated in the hands of a smaller number of regional- and domain-specific independent foundations. The public research funding agencies and major private charities have crucial roles to play in bringing the handful of large but important research institutions that have been gainers under the existing regime into the new scientific research commons. That probably is not the best place to begin, however.

In short, on this proposed journey of institutional reform, like many journeys worth undertaking for “the arrival” rather than the intrinsic pleasures of travel, one should expect to meet with impediments. In order to succeed it will demand sophisticated reconnoitering of the difficult political terrain to be traversed, careful attention to questions of sequencing, and very considerable patience and persistence. But it ought not to be deferred.

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