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User Innovator Community Norms: At the Bounds Between Academic and Industry Research

Cover Page Footnote

Professor of Law, DePaul University; Visiting Professor of Law, Fordham University School of Law (Fall 2008). This essay was prepared in part while the author was visiting at New York University School of Law during 2007–08. I am grateful for research assistance from NYU student Andrew Michaels. I also thank the other participants in this Symposium, especially Rochelle Dreyfuss, for valuable feedback and comments on an earlier draft.

USER INNOVATOR COMMUNITY NORMS: AT THE BOUNDARY BETWEEN ACADEMIC AND INDUSTRY RESEARCH

*Katherine J. Strandburg**

INTRODUCTION

The legal literature has devoted considerable attention to the tensions between patenting as a mechanism of technology transfer and the traditional norms of academic research.¹ In this essay, I consider norms of sharing research tools and materials in what has been called Pasteur's Quadrant, in which basic science and applied research overlap.² I employ a user innovation paradigm, along with a rational choice approach to social norms, to address the issue. User innovators intend to use, rather than sell, their innovative technology. They include hobbyists adapting commercial products for their individual needs as well as commercial firms developing equipment or processes for use in their factories.³

User innovators often form collaborative communities in which they share technical advances with one another in a process of "free

* Professor of Law, DePaul University; Visiting Professor of Law, Fordham University School of Law (Fall 2008). This essay was prepared in part while the author was visiting at New York University School of Law during 2007–08. I am grateful for research assistance from NYU student Andrew Michaels. I also thank the other participants in this Symposium, especially Rochelle Dreyfuss, for valuable feedback and comments on an earlier draft.

1. I will use the term "academic" throughout this essay, in part because much of the empirical work focuses on academics and industry scientists. For the most part, the discussion of academic scientists applies equally well to other scientists at nonprofit institutions.

2. DONALD E. STOKES, *PASTEUR'S QUADRANT: BASIC SCIENCE AND TECHNOLOGICAL INNOVATION* (1997).

3. See, e.g., ERIC VON HIPPEL, *DEMOCRATIZING INNOVATION* 3 (2005); Sonali K. Shah, *Open Beyond Software*, in *OPEN SOURCES 2.0: THE CONTINUING EVOLUTION* 339 (Chris DiBona et al. eds., 2006). In earlier work I argued that, since empirical evidence and common sense show that user innovation plays a major part in the invention of research tools, an infringement exemption for research tool use might be appropriate. Katherine J. Strandburg, *Users as Innovators: Implications for Patent Doctrine*, 79 U. COLO. L. REV. 467, 478 (2008); see also, e.g., Nikolaus Franke & Sonali Shah, *How Communities Support Innovative Activities: An Exploration of Assistance and Sharing Among End-Users*, 32 RES. POL'Y 157, 158 (2003); Christian Lüthje, Cornelius Herstatt & Eric von Hippel, *User-Innovators and "Local" Information: The Case of Mountain Biking*, 34 RES. POL'Y 951, 953–54 (2005).

revealing”⁴—what Robert C. Allen has called “collective invention.”⁵ Surprisingly, free revealing occurs not only among hobbyists, but also in commercial contexts among market competitors.⁶ Traditional practices of sharing research tools and materials in the academy also can be viewed as examples of free revealing in user innovator communities.

The convergence of academic research with commercial interests has two different types of consequences for sharing norms.⁷ First, a research tool or material developed in a nonprofit research context may be a dual-purpose innovation with both research and nonresearch uses. Thus, for example, a genetic assay may be useful in research and as a clinical diagnostic test; many chemicals are used in the laboratory and in industrial processes; many imaging techniques have laboratory and commercial applications; and so forth. Second, the overlap of research interests between nonprofit and industry scientists means that the user community for research tools and materials in Pasteur’s Quadrant is more diverse than in areas of purely basic research. Both of these types of overlap affect the robustness of research tool sharing norms.

4. VON HIPPEL, *supra* note 3, at 3, 9–10; *see also, e.g.*, Carliss Baldwin, Christoph Hienerth & Eric von Hippel, *How User Innovations Become Commercial Products: A Theoretical Investigation and Case Study*, 35 RES. POL’Y 1291 (2006); Emmanuelle Fauchart & Eric von Hippel, *Norms-Based Intellectual Property Systems: The Case of French Chefs*, 19 ORG. SCI. 187, 193 (2008); Franke & Shah, *supra* note 3, at 159–60; Johann Füller, Gregor Jawecki & Hans Mühlbacher, *Innovation Creation by Online Basketball Communities*, 60 J. BUS. RES. 60 (2007); Joachim Henkel, *Selective Revealing in Open Innovation Processes: The Case of Embedded Linux*, 35 RES. POL’Y 953 (2006); Jacob Loshin, *Secrets Revealed: How Magicians Protect Intellectual Property Without Law*, in LAW AND MAGIC: A COLLECTION OF ESSAYS (Christine A. Corcos ed., forthcoming 2009), available at <http://ssrn.com/abstract=1005564>; Lüthje et al., *supra* note 3; Peter B. Meyer, *Episodes of Collective Invention* 3 (U.S. Dep’t of Lab. Bureau of Lab. Statistics, Working Paper No. 368, 2003), available at <http://ssrn.com/abstract=466880>; Robert P. Merges, *From Medieval Guilds to Open Source Software: Informal Norms, Appropriability Institutions, and Innovation* 14 (Nov. 13, 2004), available at <http://ssrn.com/abstract=661543>; Andrew J. Nelson, *Institutional Convergence and the Diffusion of University-Versus Firm-Origin Technologies* 158–67 (May 11, 2007) (unpublished Ph.D. dissertation) (on file with the Fordham Law Review).

5. Robert C. Allen, *Collective Invention*, 4 J. ECON. BEHAV. & ORG. 1 (1983).

6. *See* VON HIPPEL, *supra* note 3; Allen, *supra* note 5; Fauchart & von Hippel, *supra* note 4, at 193; Henkel, *supra* note 4; Meyer, *supra* note 4, at 5, 13, 21; *see also* Baldwin et al., *supra* note 4; Franke & Shah, *supra* note 3, at 159–60; Füller et al., *supra* note 4; Lüthje et al., *supra* note 3; Loshin, *supra* note 4; Merges, *supra* note 4, at 14; Nelson, *supra* note 4, at 158–67.

7. Elsewhere I have analyzed some of the challenges posed to these traditional sharing practices in the nonprofit research community by the increasing importance of research materials and extensive databases, which cannot be shared by the low-cost mechanism of publication. *See generally* Katherine J. Strandburg, *Norms and the Sharing of Research Materials and Tacit Knowledge*, in WORKING WITHIN THE BOUNDARIES OF IP (Rochelle C. Dreyfuss et al. eds., forthcoming 2009) (on file with the Fordham Law Review).

Recent empirical studies⁸ suggest that scholars may have been overly concerned about the potential erosion of academic sharing norms due to research tool patenting per se.⁹ Scientists in both academia and industry routinely ignore patents on do-it-yourself research tools that can be “homemade” in the laboratory.¹⁰ However, while patents per se may not impede research tool sharing very significantly, research material sharing is more problematic.¹¹ Moreover, materials sharing difficulties appear to be greatest at the interface between academic and commercial research.¹²

The social norm analysis presented here predicts that the viability and robustness of practices of sharing research tools and materials depends on the differing preferences of academic and industry scientists, on whether a tool is do-it-yourself or requires access to a specific material, and on whether the tool is a garden variety research tool or a dual-purpose tool

8. STEPHEN A. HANSEN ET AL., AM. ASS'N FOR THE ADVANCEMENT OF SCI., INTELLECTUAL PROPERTY EXPERIENCES IN THE UNITED STATES SCIENTIFIC COMMUNITY: A REPORT BY THE PROJECT ON SCIENCE AND INTELLECTUAL PROPERTY IN THE PUBLIC INTEREST 24 (2007); JOHN P. WALSH, CHARLENE CHO & WESLEY M. COHEN, PATENTS, MATERIAL TRANSFERS AND ACCESS TO RESEARCH INPUTS IN BIOMEDICAL RESEARCH 2 (2005) [hereinafter WALSH ET AL., PATENTS, MATERIAL TRANSFERS AND ACCESS]; Wesley M. Cohen & John P. Walsh, *Real Impediments to Academic Biomedical Research*, in 8 INNOVATION POLICY AND THE ECONOMY 1 (Adam B. Jaffe et al. eds., 2008); John P. Walsh, Ashish Arora & Wesley M. Cohen, *Effects of Research Tool Patents and Licensing on Biomedical Innovation*, in PATENTS IN THE KNOWLEDGE-BASED ECONOMY 285, 315–16 (Wesley M. Cohen & Stephen A. Merrill eds., 2003) [hereinafter Walsh et al., *Effects of Research Tool Patents*]; John P. Walsh, Wesley M. Cohen & Charlene Cho, *Where Excludability Matters: Material Versus Intellectual Property in Academic Biomedical Research*, 36 RES. POL'Y 1184 (2007) [hereinafter Walsh et al., *Where Excludability Matters*].

9. See, e.g., Rebecca S. Eisenberg, *Bargaining over the Transfer of Proprietary Research Tools: Is This Market Failing or Emerging?*, in EXPANDING THE BOUNDARIES OF INTELLECTUAL PROPERTY: INNOVATION POLICY FOR THE KNOWLEDGE SOCIETY 223 (Rochelle Cooper Dreyfuss et al. eds., 2001); Rebecca S. Eisenberg, *Proprietary Rights and the Norms of Science in Biotechnology Research*, 97 YALE L.J. 177 (1987) [hereinafter Eisenberg, *Proprietary Rights*]; Michael A. Heller & Rebecca S. Eisenberg, *Can Patents Deter Innovation? The Anticommons in Biomedical Research*, 280 SCIENCE 698, 698–99 (1998); F. Scott Kieff, *Facilitating Scientific Research: Intellectual Property Rights and the Norms of Science—A Response to Rai and Eisenberg*, 95 NW. U. L. REV. 691 (2001); Fiona Murray & Scott Stern, *Do Formal Intellectual Property Rights Hinder the Free Flow of Scientific Knowledge? An Empirical Test of the Anti-Commons Hypothesis*, 63 J. ECON. BEHAV. & ORG. 648 (2007); Arti Kaur Rai, *Evolving Scientific Norms and Intellectual Property Rights: A Reply to Kieff*, 95 NW. U. L. REV. 707 (2001) [hereinafter Rai, *Evolving Scientific Norms*]; Arti Kaur Rai, *Regulating Scientific Research: Intellectual Property Rights and the Norms of Science*, 94 NW. U. L. REV. 77, 80 (1999) [hereinafter Rai, *Regulating Scientific Research*]; Paul A. David, *Can 'Open Science' Be Protected from the Evolving Regime of IPR Protections?* (Working Paper) (n.d.), available at <http://siepr.stanford.edu/papers/pdf/02-42.pdf>.

10. See, e.g., WALSH ET AL., PATENTS, MATERIAL TRANSFERS AND ACCESS, *supra* note 8, at 15–16, 26–27; Cohen & Walsh, *supra* note 8, at 12; Walsh et al., *Where Excludability Matters*, *supra* note 8, at 1188–91, 1199.

11. WALSH ET AL., PATENTS, MATERIAL TRANSFERS AND ACCESS, *supra* note 8, at 19–20, 27–28; Cohen & Walsh, *supra* note 8, at 15; Walsh et al., *Where Excludability Matters*, *supra* note 8, at 1191–94, 1199.

12. WALSH ET AL., PATENTS, MATERIAL TRANSFERS AND ACCESS, *supra* note 8, at 25; Walsh et al., *Where Excludability Matters*, *supra* note 8, at 1191, 1193–94.

with a significant nonresearch market. To understand sharing practices, empirical studies should seek to disentangle these variables. Policy prescriptions for enhancing sharing also should account for these factors.

Part I of this essay briefly reviews the rational choice theory of social norms and applies it to the general context of user innovator sharing. It then describes a "*homo scientificus*" preference model of scientists¹³ and explains briefly how the traditional Mertonian norm of communalism,¹⁴ as applied to the sharing of research tools and methods, can be understood as a response to collective action problems in an academic researcher innovator community. Part II considers the impact of the two types of convergence between industry and academic research identified above on the potential for sharing norms and interprets empirically observed research tool and materials sharing practices in light of the theory. Part III discusses how policy initiatives can promote "ignoring patents" and materials sharing norms. It notes that, at least in some circumstances, sharing norm viability may depend on preserving boundaries between academic and industry uses of research tools and discusses the roles that patents and other policy mechanisms might play in preserving or breaching such barriers. Part IV concludes by summarizing the analysis and suggesting ways to encourage research tool and materials sharing.

I. A SOCIAL NORM THEORY OF SHARING RESEARCH TOOLS AND MATERIALS

A. *Sharing in User Innovator Communities*

When scientists develop research tools and materials, they are generally acting as user innovators since they are motivated to develop the tools for their own research use. User innovators frequently come together in innovative communities, sharing and building upon one another's inventions.¹⁵ While this may not be surprising in the case of some noncompetitive groups of hobbyists, it is common even among commercial actors and even when the members of the community are competitive with one another.¹⁶

There have been a number of fascinating case studies of "free revealing" or "collective invention" in what turn out upon reflection to be user

13. Katherine J. Strandburg, *Curiosity-Driven Research and University Technology Transfer*, in 16 ADVANCES IN THE STUDY OF ENTREPRENEURSHIP, INNOVATION AND ECONOMIC GROWTH 93, 95 (Gary D. Libecap ed., 2005).

14. See ROBERT K. MERTON, *THE SOCIOLOGY OF SCIENCE: THEORETICAL AND EMPIRICAL INVESTIGATIONS* (1973); Rai, *Regulating Scientific Research*, *supra* note 9, at 90; Erik Ernø-Kjølhede, *Scientific Norms as (Dis)integrators of Scientists?* (Copenhagen Bus. Sch., Working Paper No. 14/2000, 2000).

15. See Baldwin et al., *supra* note 4; Franke & Shah, *supra* note 3, at 160; Füller et al., *supra* note 4; Lüthje et al., *supra* note 3; Meyer, *supra* note 4, at 3; *supra* note 4.

16. See VON HIPPEL, *supra* note 3; Fauchart & von Hippel, *supra* note 4, at 193; Henkel, *supra* note 4; Loshin, *supra* note 4; Meyer, *supra* note 4, at 5, 13, 21.

innovator communities whose members develop or improve technology for their own use.¹⁷ Communities that have been studied in detail include iron-making companies in the 1850s,¹⁸ Venetian glass-making guilds in the 1400s,¹⁹ open source software programmers,²⁰ steel makers in the 1850s,²¹ the “Mouse Men of America” in biological research,²² computer clubs,²³ skateboarders,²⁴ and mountain bikers.²⁵ The similarities between the scientific community and these communities are frequently mentioned.²⁶ The general picture that emerges from these studies is that user innovators share their technical advances with other community members in rough exchange for access to technical advances made by the others.²⁷

Particularly interesting for present purposes is the fact that many of these communities consist of user innovators who compete with one another to some extent, either in the marketplace or in other venues.²⁸ For example, commercial competitors are now major contributors to the development of certain commonly used open source software programs, such as Linux.²⁹ On the hobbyist end, user communities of athletes, who often combine sharing with competition, are among the most well-studied.³⁰

Such communities succeed when users benefit from each other’s innovations, as will tend to be the case in a group that is not purely competitive; that is, members benefit when the community as a whole advances. Thus, competing user innovators share innovations because there

17. See VON HIPPEL, *supra* note 3; Baldwin et al., *supra* note 4; Fauchart & von Hippel, *supra* note 4, at 192–94; Franke & Shah, *supra* note 3, at 160; Lüthje et al., *supra* note 3; Shah, *supra* note 3; Meyer, *supra* note 4, at 3.

18. Meyer, *supra* note 4, at 4–5.

19. Merges, *supra* note 4, at 14–16.

20. STEVE WEBER, *THE SUCCESS OF OPEN SOURCE* (2004); Karim Lakhani & Eric von Hippel, *How Open Source Software Works: “Free” User-to-User Assistance?*, 32 RES. POL’Y 923 (2003); Josh Lerner & Jean Tirole, *Some Simple Economics of Open Source*, 50 J. INDUS. ECON. 197 (2002).

21. Meyer, *supra* note 4, at 7.

22. Fiona Murray, *The Oncomouse that Roared: Hybrid Exchange Strategies as a Source of Productive Tension at the Boundary of Overlapping Institutions*, AM. J. SOC. (forthcoming 2009) (manuscript at 19, on file with the Fordham Law Review).

23. Meyer, *supra* note 4, at 5–6.

24. Shah, *supra* note 3, at 347–50.

25. Lüthje et al., *supra* note 3.

26. See, e.g., VON HIPPEL, *supra* note 3; Jean-Michel Dalle & Paul A. David, *The Allocation of Software Development Resources in Open Source Production Mode*, in PERSPECTIVES ON FREE AND OPEN SOURCE SOFTWARE 297, 324 n.5 (Joseph Feller et al. eds., 2005).

27. VON HIPPEL, *supra* note 3.

28. Fauchart & von Hippel, *supra* note 4; Franke & Shah, *supra* note 3, at 160, 170; Henkel, *supra* note 4; Loshin, *supra* note 4; Shah, *supra* note 3; Meyer, *supra* note 4, at 5, 13, 21.

29. Siobhán O’Mahony & Fabrizio Ferraro, *Managing the Boundary of an ‘Open’ Project*, in MARKET EMERGENCE AND TRANSFORMATION (John Padgett & Walter Powell eds., forthcoming 2010), available at http://www.umass.edu/digitalcenter/events/pdfs/OMahony_open_project.pdf.

30. Baldwin et al., *supra* note 4; Franke & Shah, *supra* note 3, at 160; Lüthje et al., *supra* note 3; Shah, *supra* note 3.

are trade-offs between internal competition between members and the benefits of sharing. Sharing can be rewarding in several ways: it may be a prerequisite for access to innovations made by other community members; it may be a prerequisite for reputational and other rewards offered by the community; it may lay a user's innovation open to improvement by other members of the community; or it may simply promote the overall enterprise of the group. For a variety of reasons—including personal satisfaction in improved performance, appreciation of improved output of the group's activity, and competition between the group and "outsiders"—even competitive users often value the general success of the user community. So, for example, members of a competitive tennis club might enjoy the games more if all players improve or have access to better equipment; scientific researchers might enjoy having more complete scientific knowledge and better research tools even if they have to share them; and an entire industry might be in competition with producers of potential substitutes or with other seekers of investment capital.³¹

Rational choice theory describes how informally enforced social norms can solve collective action problems in close-knit, repeatedly interacting communities as long as deviations from the norm can be detected and punished by community members.³² The theory grounds social norms in the private preferences of community members and explains cooperative behavior in terms of rational utility maximization.³³ The norms of interest to us here are sanction-driven norms, enforced by informal penalties that are often reputational in nature, but may also involve more direct punishments such as withholding resources under the group's control.³⁴

In a rational choice model, the stability and viability of a sanction-driven norm depends on three things: (1) the fact that the norm is beneficial for community members in light of their preferences; (2) the community's ability to detect defections from the norm; and (3) the community's ability to impose penalties that are sufficient to deter defection yet not so costly to impose that they overwhelm the coordination benefit.³⁵

The sharing propensity of user innovator communities can be parameterized in a simple model that captures at least some of the most important tradeoffs involved in a user's decision whether to share an innovation with a community of similar users. Assume for the moment that all members of a user innovator community are equivalent in their

31. It is worth noting here that, like social norms more generally, sharing norms that arise to benefit a particular community need not be optimal for society at large. While this is generally not an issue in the context of research tool invention, I return to this point briefly when I discuss the issue of materials transfer across the boundary between academia and industry.

32. STEVEN A. HETCHER, *NORMS IN A WIRED WORLD* (2004); Richard H. McAdams, *The Origin, Development, and Regulation of Norms*, 96 MICH. L. REV. 338, 355 (1997).

33. HETCHER, *supra* note 32; McAdams, *supra* note 32, at 355–76.

34. See, for example, HETCHER, *supra* note 32, at 58–59, for a discussion of social norms as solutions to iterated prisoner's dilemmas.

35. HETCHER, *supra* note 32; McAdams, *supra* note 32, at 358.

production and consumption of innovations and also equally able to benefit from refusing to share their innovations so that they can use them exclusively.³⁶ Assume also that, because these are user innovators, they innovate for their own use regardless of what they expect others to do. Often this is a reasonable assumption because innovation is a relatively low cost endeavor for user innovators, whose innovations derive from experience gained in the course of pursuing their normal activities. In any event, I assume here that the choice to innovate is driven by use and hence exogenous to the decision whether to share. The model analyzes the choice whether to share a newly developed innovation with others in a user community.

Let U be the value of nonexclusive use of an innovation developed by another user. In the context of scientific research, for example, scientists may gain intrinsic enjoyment from doing research using new tools; they may derive direct satisfaction from the advancement of the field made possible by new tools; or they may use a tool nonexclusively to make the minimal scientific advances necessary to keep them “at par” with other researchers and involved in the community.

Of course, even if she shares her innovation with other users, the user who developed a research tool may retain some advantage in using it as a result of skill, tacit knowledge, tailoring of the innovation to her particular interests, or similar factors. Let such first mover advantage be denoted M . The value of using one’s own innovation nonexclusively is thus $U + M$, while the value of using someone else’s innovation is simply U .

Rather than share his or her innovation with others, a user might seek to use it exclusively. If the members of a community are in competition with one another, exclusive use of an innovation may provide a competitive advantage. Define E to be the *increase* in an innovation’s value to its user developer when she uses it exclusively; the total value to the innovator of exclusive use of her innovation is thus $U + E$. In the model, E is the *net* additional benefit of exclusive use. It reflects both the costs and the benefits of exclusivity. In many, if not most, user innovator communities, E is positive because exclusive use gives a user innovator a leg up in intragroup competition. The decision to share then reflects a trade-off between the advantages of sharing and the benefits of exclusive use. For some innovation, E may even be negative. For example, some innovations become more valuable when they are shared, perhaps as a result of a need for standardization or of the need for access to the heterogeneous talents of the user innovator community to optimize their value. In other cases, the costs of maintaining exclusivity outweigh the benefits of exclusive use, so that E is negative.

36. I also assume here that sharing an invention means sharing it with the entire group. In many cases—such as when sharing is accomplished through publication or by demonstrating or using the invention in a group context or when social processes within the group ensure that information will spread throughout the group—this is a realistic assumption. I return to this point when discussing materials sharing below.

Two additional parameters in the model reflect the costs and benefits of sharing an innovation with the user community. Let C be the cost of sharing an innovation (often, for example, by publication). I have more to say about sharing costs below. Let R be any reward, other than access to the innovations of other users in the community, that a user receives in return for sharing an innovation. The reward R might, for example, include reputational benefits or intrinsic enjoyment of contributing to community discourse. Finally, assume there are N members of the user community.

A member (whom we will call A) will make a strategic choice of whether to share her innovation based on what she expects other members to do. In making that choice in our simplified model, user A will assume that the $N - 1$ other users, faced with identical incentives, will make identical choices. In this symmetric situation, the "payoffs" that user A would expect in light of how the others might behave will look like this:

		Other User Innovators	
		Share	Don't Share
User Innovator A	Share	$NU + M + R - C$	$U + M + R - C$
	Don't Share	$NU + E$	$U + E$

If all community members share (the upper left hand corner above), member A has access to $N - 1$ innovations shared by the others. Because member A shares, her own innovation is worth $U + M$ to her (she gets a first mover advantage, but no exclusivity advantage) and she receives the rewards of and incurs the costs of sharing. Her net payoff is thus $NU + M + R - C$. If none share (the lower right hand corner), member A is restricted to using her own innovation exclusively and her payoff is $U + E$. If member A shares and the others do not (the upper right hand corner), member A receives only the benefit of using her own innovation nonexclusively, $U + M$, along with the rewards and costs of sharing. If member A does not share and the others do (lower left hand corner), A benefits nonexclusively from all the other innovations, $(N - 1)U$, and exclusively from her own, $U + E$. In choosing her course of action, A will consider her prospective payoffs in light of either course of action by the rest of the community.

Inspecting the matrix, one can see that sometimes there may be no need for a sharing norm. If the first mover advantages, M , and other rewards for sharing bestowed by the community, R , are large enough and sharing is relatively cheap, the benefits of exclusivity may be outweighed by the rewards of sharing; that is, $M + R - C > E$. In this case, A will prefer to share her innovation, regardless of what the others do. Because all user innovators are identical in the model, all will share. In this happy situation, there is no need for a social norm to enforce sharing.

However, a less felicitous situation may arise. It may be that the rewards for sharing are not enough to motivate user innovator A (and all her identical colleagues) to share unless she can be sure that everyone else will share as well. Thus, if $M + R - C < E$, user A will not make an independent choice to share. Indeed, no one will share and everyone will receive only the benefit of exclusive use of his or her own innovation, $U + E$. This is an unfortunate situation for the user community (indeed, it is a classic collective action problem) if the benefit to each user of sharing all of the innovations would have outweighed the advantage of using her own tool exclusively. Thus, if $(N - 1)U + M + R - C > E > M + R - C$, all user innovators would benefit from a means to ensure that everyone in the community shares. In this situation, a social norm of sharing is desirable. Such a norm is viable as long as the group can detect failure to share and impose a sufficient penalty (or equivalently increase the reward for sharing) at a relatively low cost. Professor Richard McAdams has argued, for example, that esteem penalties are costless to impose.³⁷ In any event, as long as the cost of the penalty is low enough, the group will be willing in principle to impose it. (I do not deal here with the question of the mechanism by which such a norm is established.)

To summarize, depending on the values of U , M , R , C , and E , there are three regimes:

Regime I: $M + R - C > E$, the benefits of sharing one's own innovation are enough to induce sharing regardless of what others do; no social norm is necessary;

Regime II: $(N - 1)U + M + R - C > E > M + R - C$, sharing is preferable if everyone shares; a social norm is desirable to coordinate sharing;

Regime III: $E > (N - 1)U + M + R - C$, the exclusivity payoff outweighs the benefits of sharing; user innovators will not share.

The viability of sharing norms thus depends on the preference structure of the user innovator community under consideration, which determines the relative values of U and E . Specifically, the extent to which a group of competitive user innovators benefits by sharing depends upon the trade-off between the competitive advantages of exclusivity and the advantage to each group member of the advancement of the group's technology as a whole. These trade-offs are captured in the simple model by the relative values of $(N - 1)U$, and E . In general, the value of one user's innovation to other users, U , is likely to be relatively high simply because both are engaged in using the same technology.

In his article, *Episodes of Collective Invention*, Peter Meyer notes that shared innovative activity tends to characterize the early phase of establishment of an industry.³⁸ This timing makes sense in light of the simple model examined here: the relative benefits of promoting the industry as a whole vis-à-vis competing industries tend to dominate the

37. McAdams, *supra* note 32, at 357-58.

38. Meyer, *supra* note 4, at 15-17.

benefits of exclusive use of an innovation in intragroup competition during such phases.

The viability of a sharing norm also depends on the rewards bestowed for sharing, and also, importantly, on the costs of sharing, which depend on the nature of a given innovation. In particular, norms of sharing are more tenable when the costs of sharing an innovation are relatively low. The cost of sharing, C , is likely to be low for user innovations. User innovations will tend to depend on the particular kinds of expertise and information possessed by users of a technology.³⁹ Because other users share much of this expertise and information, they will probably have reasonably high "absorptive capacity"⁴⁰ and be able to pick up and use innovations developed by other users relatively easily.⁴¹ Thus, the costs of disseminating user innovations within a user community will tend to be relatively small compared to the costs of disseminating innovations in more traditional consumer situations. Many of the user innovation communities studied so far have employed publication as a means of sharing their innovations.⁴² Publication is a relatively cheap method of dissemination and its marginal cost is low. Moreover, it is particularly effective where absorptive capacity is high.

Sharing will tend to be favored as a user innovator group gets larger because the pool of shared innovations (and hence $(N-1)U$) gets larger. However, in some cases, the costs of sharing or the benefits of exclusivity may also rise as the number in the group increases, thus tending to decrease the net desirability of sharing. It will also be more difficult to enforce an informal sharing norm in a larger group. Informal norms depend on detecting deviations from the norm and on the ability to impose penalties, which usually are based on repeated interactions and often on reputation.⁴³ As a group gets larger, informal norms may become less effective, and it may or may not be possible for a group to reinforce a norm by imposing more formal rules.

There are many limitations to the simple model described here, some of which are important for research tool and material sharing in Pasteur's Quadrant. The model assumes a homogeneous group, for example, in which all innovations are of equal value to all participants, and all participants have the same costs and benefits of sharing and exclusivity. In reality, some participants will be motivated more than others to defect from a sharing norm for a variety of reasons, including greater ability to benefit from exclusivity. Heterogeneity in the quality of innovations is constrained to some extent in the scientific context by academic requirements such as

39. VON HIPPEL, *supra* note 3.

40. *Id.* at 68-70; Wesley M. Cohen & Daniel A. Levinthal, *Absorptive Capacity: A New Perspective on Learning and Innovation*, 35 ADMIN. SCI. Q. 128 (1990).

41. Strandburg, *supra* note 3, at 513.

42. Füller et al., *supra* note 4; Meyer, *supra* note 4, at 8-11.

43. ROBERT C. ELLICKSON, *ORDER WITHOUT LAW: HOW NEIGHBORS SETTLE DISPUTES passim* (1991); HETCHER, *supra* note 32; McAdams, *supra* note 32, at 357-58.

the Ph.D. degree, “publish or perish” tenure requirements, and peer review. Nonetheless, there can still be research tool “blockbusters,” which will provide incentives to defect from sharing that outweigh the penalties imposed by the group. As the number of defectors increases, the benefits of participation in the sharing group decrease, as does the group’s ability to penalize defectors. Such heterogeneity might in some circumstances set off a destabilizing cascade that would destroy a sharing norm.⁴⁴ On the other hand, qualitative heterogeneity in skills, knowledge, use experiences, and so forth increases the rewards of sharing because innovations tend to be complementary and thus tend to stabilize sharing.

The model of a binary choice between sharing and exclusivity is also highly oversimplified. User innovator communities often exhibit complicated norm regimes of sharing and exclusivity,⁴⁵ possibly reflecting the relative costs and benefits of sharing certain types of innovations. Moreover, it is possible to balance the benefits of exclusivity and sharing by controlling the timing of sharing, using an invention exclusively for a period of time before sharing it with the community.⁴⁶ This is, in fact, what seems to be the norm in scientific research.⁴⁷

The approximation of rational utility maximization itself is subject to various sorts of critique, one of the most important of which is that many individuals appear to be “reciprocators” who are more inclined to cooperate than might be expected from a utility maximization approach.⁴⁸ The Prisoner’s Dilemma-type analysis, in which all group members decide once and for all and simultaneously whether to share, is also highly oversimplified. Finally, as I discuss in greater detail in the research tool context, the discussion so far has not accounted for a group’s interaction with outsiders. If the benefits or costs of a group’s sharing practices spill over to outsiders, this can affect both the social desirability and the robustness of a sharing norm.

Despite these limitations, the model provides useful insights into the determinants of user innovator community sharing. The next section applies the insights from this rather abstract treatment to research tool sharing in the purely academic context⁴⁹ as a predicate to the Pasteur’s Quadrant analysis in Part II.

44. See, e.g., Jonathan Barnett, *Sharing in the Shadow of Property: Rational Cooperation in Innovation Markets* (Univ. S. Cal. Ctr. in Law, Econ. & Org., Research Paper No. C08-22, 2008), available at <http://ssrn.com/abstract=1287283>.

45. Fauchart & von Hippel, *supra* note 4, at 192–94; Henkel, *supra* note 4; Loshin, *supra* note 4; Meyer, *supra* note 4, at 4, 17–20.

46. Henkel, *supra* note 4.

47. Strandburg, *supra* note 13, at 109–13.

48. See, e.g., Russell B. Korobkin & Thomas S. Ulen, *Law and Behavioral Science: Removing the Rationality Assumption from Law and Economics*, 88 CAL. L. REV. 1051, 1138–43 (2000).

49. For a more detailed discussion of sharing of research tools and materials among nonprofit researchers, see Strandburg, *supra* note 7.

B. "Homo Scientificus" and Research Tool Sharing in the Ivory Tower

When a technology is employed in researching the properties of something else, it functions as a research tool or method (often collectively denominated "research tools" in the literature). Research tools and methods more often than not⁵⁰ are developed by researchers and thus are user innovations. The "research tool" category is somewhat ill-defined, since a technology may often be employed both as a tool for research and in some other way. A microscope, for example, can be used in research, but can also be used to read the results of a diagnostic test. Similarly, the common laboratory chemical acetone can be used in research or to remove nail polish. A list of "research tools" provided by a National Institutes of Health report is illustrative, at least in the biotechnology arena: "[T]he term may . . . include cell lines, monoclonal antibodies, reagents, animal models, growth factors, combinatorial chemistry libraries, drugs and drug targets, clones and cloning tools (such as [polymerase chain reaction (PCR)]), methods, laboratory equipment and machines, databases and computer software."⁵¹

Though the eventual goal of this essay is to illuminate the impact of interactions between academic and industrial science on sharing of research tools and materials, it is useful to start by considering briefly why a group of traditional ivory tower scientists might develop sharing norms. Sociologist Robert Merton⁵² identified the norms of the scientific community as universalism, communalism, disinterestedness, and organized skepticism.⁵³ A norm of sharing research tools and materials is an example of communalism. In terms of the simple model developed in Section I.A, the viability of a sharing norm depends on the values of *U*, *C*, *R*, and *E*, all of which are determined to a large extent by the preferences of the members of the community.

Scientists, like other people, vary in their preferences and values. But, just as a model of human beings as rational wealth maximizers is often useful in understanding both average and collective behavior, an approximate model of a typical researcher may be used to understand the behavior of the scientific community and predict its likely responses to legal and social changes. Based on empirical evidence discussed in detail

50. William Riggs & Eric von Hippel, *Incentives to Innovate and the Sources of Innovation: The Case of Scientific Instruments*, 23 RES. POL'Y 459 (1994).

51. NAT'L INSTS. OF HEALTH, REPORT OF THE NATIONAL INSTITUTE OF HEALTH WORKING GROUP ON RESEARCH TOOLS: PRESENTED TO THE ADVISORY COMMITTEE TO THE DIRECTOR (1998), available at <http://www.nih.gov/news/researchtools/index.htm> [hereinafter NIH REPORT].

52. MERTON, *supra* note 14; Rai, *Regulating Scientific Research*, *supra* note 9, at 89 & n.65.

53. Professors Rebecca Eisenberg and Arti Rai have written extensively on the subject of the potential adverse effects that the Bayh-Dole Act and other attempts to define commercial and proprietary rights in basic research results might have on traditional scientific norms. See Eisenberg, *Proprietary Rights*, *supra* note 9; Rai, *Regulating Scientific Research*, *supra* note 9, at 115-16.

elsewhere,⁵⁴ I model the academic scientist as an individual with strong preferences for (1) performing scientific research and participating in the scientific discourse; (2) exercising autonomy in choosing the topic and direction of his or her research; and (3) learning the results of the collective research project.⁵⁵

These preferences suggest that academic scientists will have a high value of U —ability to benefit from using research tools that are also available to other scientists. The scientific community is also able to provide relatively large rewards, R , both reputational and in the form of collaboration and research funding, to those who share their research tool innovations with the community. In the absence of patenting, the openness of the academic context also limits the extent to which a researcher innovator can benefit from exclusivity. Therefore, E tends to be rather small. When a research tool invention can be shared by the relatively low-cost mechanism of publication, C is also small. It is thus highly likely that the academic research community will find itself in Regime I or II of the model and that a sharing norm will be desirable.

The scientific community is also well-situated to enforce a sharing norm in light of the *homo scientificus* preference structure. *Homo scientificus* needs two primary scarce resources to satisfy his or her preferences: research funding and the attention of other scientists.⁵⁶ Because of the predominance of peer review mechanisms for allocating funding and publication, the community is well-positioned to enforce norms using its power to allocate these resources.

54. See Strandburg, *supra* note 13; Strandburg, *supra* note 3.

55. Cf. J. H. Reichman & Paul F. Uhler, *A Contractually Reconstructed Research Commons for Scientific Data in a Highly Protectionist Intellectual Property Environment*, LAW & CONTEMP. PROBS., Winter/Spring 2003, at 315, 335 (“[A]cademic researchers typically are not driven by the same motivations as their counterparts in industry. . . . Rather, the motivations of not-for-profit scientists are predominantly rooted in intellectual curiosity, the desire to create new knowledge, peer recognition and career advancement, and the promotion of the public interest.” (citing Eisenberg, *Proprietary Rights*, *supra* note 9, at 178)). It seems plausible that life scientists in particular are also substantially motivated by a desire to contribute to society. It is unclear, however, whether university researchers differ from those who go into industry in this regard. While academic research may be less “tainted” by commercial concerns, industrial research is more practical and may be more immediately geared toward contributing to public health. Certainly commercialization of university research can contribute significantly to the public good and no doubt many researchers are motivated to assist in the commercialization of their discoveries by public interested motives. Thus, it is important in general to keep these public-spirited motivations in mind. The analysis here and in my earlier treatment of this question demonstrates, however, that there is no need to assume that university researchers are more public-spirited than commercial researchers to account for the traditional research norms in a rational choice theory.

56. There are exceptions to this contention, of course: some sufficiently theoretical work may require no more than pencil and paper, and some individual scientists may work independent of collaborators and keep up with the progress of others purely by reading scientific journals. But such scientists are extremely rare. Most scientific work requires significant funding and most researchers work collaboratively.

Increased university patenting, particularly in the life sciences, has inspired fears that sharing norms would break down and research would be significantly slowed or stymied by the need to obtain preauthorization from research tool patentees.⁵⁷ Recent empirical work suggests that research tool patents have had much less negative impact on research than might have been anticipated.⁵⁸ The relatively minor impact of research tool patents is not due to any lack of patents on research tools or to widespread patent licensing. Instead, it appears that patents are simply not being enforced against research use.⁵⁹ There is a norm of ignoring patents for research tool use, consistent with academic preferences for research tool sharing.

On the other hand, there appear to be more significant difficulties with sharing of research materials, particularly across the industry-academic boundary. This is understandable from the social norm model because the costs of sharing research materials are significantly higher than the costs of sharing do-it-yourself tools, which can be disseminated by publication alone. Indeed, for the developer of a research material, sharing costs will tend to be proportional to the number of members of the scientific community: in the model, C becomes $(N-1)C$. In such cases, the net exclusivity premium, E , also increases because the costs of maintaining exclusivity are reduced since scientists can publish and present research results without sharing a research material.

The range of viability of sharing norms will be reduced in these cases. Nonetheless, even for research materials, sharing norms are still likely to be common within a purely ivory tower research community given the extent to which academic scientists value the use of shared research tools. Moreover, there are a variety of steps, including most importantly the establishment of centralized tool distribution mechanisms, that can mitigate the costs of sharing in these cases and boost the attractiveness of sharing practices.⁶⁰

57. For a review, see Katherine J. Strandburg, *The Research Exemption to Patent Infringement: The Delicate Balance Between Current and Future Technical Progress*, in INTELLECTUAL PROPERTY AND INFORMATION WEALTH: ISSUES AND PRACTICES IN THE DIGITAL AGE 107, 112–15 (Peter K. Yu ed., 2007) [hereinafter Strandburg, *Delicate Balance*]. See generally Rochelle Dreyfuss, *Protecting the Public Domain of Science: Has the Time for an Experimental Use Defense Arrived?*, 46 ARIZ. L. REV. 457 (2004); Rebecca S. Eisenberg, *Patents and the Progress of Science: Exclusive Rights and Experimental Use*, 56 U. CHI. L. REV. 1017, 1024–28 (1989); Heller & Eisenberg, *supra* note 9; Janice M. Mueller, *The Evanescent Experimental Use Exemption from United States Patent Infringement Liability: Implications for University and Nonprofit Research and Development*, 56 BAYLOR L. REV. 917 (2004); Janice M. Mueller, *No "Dilettante Affair": Rethinking the Experimental Use Exception to Patent Infringement for Biomedical Research Tools*, 76 WASH. L. REV. 1 (2001); Maureen A. O'Rourke, *Toward a Doctrine of Fair Use in Patent Law*, 100 COLUM. L. REV. 1177 (2000); Katherine J. Strandburg, *What Does the Public Get? Experimental Use and the Patent Bargain*, 2004 WIS. L. REV. 81.

58. WALSH ET AL., PATENTS, MATERIAL TRANSFERS AND ACCESS, *supra* note 8, at 37; Walsh et al., *Effects of Research Tool Patents*, *supra* note 8, at 331.

59. WALSH ET AL., PATENTS, MATERIAL TRANSFERS AND ACCESS, *supra* note 8, at 3–4, 37; Walsh et al., *Effects of Research Tool Patents*, *supra* note 8, at 324–28.

60. See, e.g., Strandburg, *supra* note 7.

II. SOCIAL NORMS IN PASTEUR'S QUADRANT: THE IMPLICATIONS OF ACADEMIC/INDUSTRY OVERLAP

Up to this point, I have taken a traditional “ivory tower” view of academic research. This traditional perspective may well remain roughly accurate in many fields, where industry funding and interaction remain minimal and patenting is rare.⁶¹ In some areas, however, including notably, but certainly not exclusively, the life sciences, increasing overlap between fundamental research and commercial application has rendered this framework outmoded. As noted in the Introduction, the growing overlap of commercial and academic interests in Pasteur’s Quadrant raises at least two issues that may affect the stability of research tool sharing norms. First, there is the issue of dual-purpose tools. In Pasteur’s Quadrant, one person’s research tool may be another’s commercial product.⁶² Second, the scientific overlap means that industry scientists are engaged in research projects similar to those in which university researchers are involved. The preferences of research tool user innovators are thus heterogeneous in Pasteur’s Quadrant research.⁶³

61. Magnus Gulbrandsen & Jens-Christian Smeby, *Industry Funding and University Professors’ Research Performance*, 34 RES. POL’Y 932, 940 (2005) (presenting statistics on industry funding of research for different academic disciplines).

62. Of course, a research tool can always be a commercial product from the perspective of a tool supplier. Here I mean to discuss inventions that have alternative commercial uses in addition to their use in conducting research.

63. Each of these kinds of overlap might affect the viability of norms of sharing research tools and materials. These effects are distinct from other important effects that interactions between academic and commercial researchers may have on the *direction* of research. See, e.g., Brett Frischmann, *The Pull of Patents*, 77 FORDHAM L. REV. 2143 (2009); Strandburg, *supra* note 13. The question of research tool sharing between industry and nonprofit researchers is also mostly distinct from questions about the most effective means of technology transfer of “embryonic” university inventions to the commercial sector. Research tools, methods, and materials that are traditionally shared by a purely academic researcher community will not be “embryonic”—at least from the researcher perspective. See, e.g., Frischmann, *supra*. For overviews of research into the relationship between university patenting and technology transfer, see generally DAVID C. MOWERY ET AL., *IVORY TOWER AND INDUSTRIAL INNOVATION: UNIVERSITY-INDUSTRY TECHNOLOGY TRANSFER BEFORE AND AFTER THE BAYH-DOLE ACT IN THE UNITED STATES* (2004); Nicola Baldini, *University Patenting and Licensing Activity: A Review of the Literature*, 15 RES. EVALUATION 197 (2006); Paul A. David et al., *Is Public R&D a Complement or Substitute for Private R&D? A Review of the Econometric Evidence*, 29 RES. POL’Y 497 (2000); Bhaven Sampat, *Patenting and US Academic Research in the 20th Century: The World Before and After Bayh-Dole*, 35 RES. POL’Y 772, 772–89 (2006); Jerry Thursby & Marie Thursby, *Knowledge Creation and Diffusion of Public Science with Intellectual Property Rights*, in 2 INTELLECTUAL PROPERTY, GROWTH AND TRADE 199 (Keith E. Maskus ed., 2008); Robert E. Litan et al., *Commercializing University Innovations: Alternative Approaches* (Nat’l Bureau of Econ. Res., Working Paper, 2007), available at <http://ssrn.com/abstract=976005>.

A. *Dual-Purpose Innovations and an "Ignore Patents" Norm*

Tools, methods, and materials developed for use in research may have alternative uses as consumer products.⁶⁴ For example, an assay may have uses both in research and as a clinical test.⁶⁵ The availability of a lucrative commercial market for such dual-purpose research tools changes the incentives for both academic and industry researcher innovators, and thus, affects the viability of sharing norms. The results are somewhat counterintuitive: because patents can be enforced selectively against commercial competitors and ignored in the research context, they can play a role in preserving, and even expanding, a research tool sharing norm for dual-purpose research tools. This use of patents to delineate research and commercial uses may explain why a norm of sharing unpatented research tools would evolve into a norm of ignoring patents for dual-purpose research tools.

1. Sharing of Do-It-Yourself Dual-Purpose Tools

I begin by discussing do-it-yourself research tools, which can be shared with other researchers by publication without the need to transfer materials, extensive datasets, or tacit knowledge. Table I summarizes this analysis. An overlap of research and commercial uses dramatically changes incentives for academic researchers to patent their do-it-yourself tool innovations: rather than providing a limited-time leg up in the research race, such innovations are potential sources of significant monetary income. A patent may be used to exclude competing sellers or to collect revenue from commercial users and may also be helpful in attracting a commercial partner to assist in bringing a product to market.⁶⁶ When, as is often the case, dual-purpose inventions relate to important health, agricultural, or other social issues, even a publicly minded inventor (or her institution) may want patent exclusivity in order to exercise control over the terms under which an invention is marketed, using a patent to negotiate terms such as a requirement that some effort be directed to serving the needs of low-income consumers or those in developing countries.⁶⁷

64. See generally NIH REPORT, *supra* note 51; Strandburg, *Delicate Balance*, *supra* note 57, at 146.

65. Arti K. Rai, *Genome Patents: A Case Study in Patenting Research Tools*, 77 ACAD. MED. 1368 (2002).

66. It makes sense to speak of a commercial supplier of a do-it-yourself dual-purpose research tool because what is do-it-yourself for researchers may not be do-it-yourself for consumers, either because of issues of absorptive capacity or because of the need for further development of the innovation for commercial use.

67. Whether the use of a patent on a university invention to protect commercial sales is beneficial from a public policy perspective depends on to what extent the patent is needed to motivate commercial firms to invest in commercializing the invention, to what extent patent exclusivity is used to compensate the university inventor for assisting with commercialization, and to what extent improvements made to prepare the invention for a commercial market are themselves patentable. This is, of course, the familiar debate over the virtues of the Bayh-Dole Act and university patenting in general. One distinguishing

One might at first anticipate that patenting dual-purpose inventions would raise the exclusivity premium, E , so much that the traditional academic sharing norm would be destroyed. However, this need not be the case. While the profit from exclusive commercial sales may be larger than the value of sharing within the scientific community, it may not be necessary to choose between them. It may be possible to share tools and methods *for use in research* while making exclusive commercial sales. The benefit from exclusive *research* use of a dual-purpose invention (as distinct from exclusive commercial sales) is often no larger than the benefit of exclusive research use of any garden variety research tool or method. The rewards and costs of publication as a means of sharing the tool with other scientists are similarly unaffected by whether the tool also has a commercial market.⁶⁸ Thus, if scientists can divorce research use from exploitation as a commercial product, it may still be possible to preserve a sharing norm for research use only.

For do-it-yourself tools, this requires a means to make an invention available to other scientists through publication while maintaining exclusivity with regard to commercial sales. In this situation, patents, which require disclosure while maintaining exclusivity, are perfectly suited to maintaining a research tool commons among scientists while maintaining exclusive sales. A social norm of enforcing patents only against those who make commercial use of an innovation,⁶⁹ and not against those who use it as a research tool, is likely to be both viable and desirable to the academic science community. Such a norm would be relatively easily enforceable since researchers on the receiving end of patent enforcement attempts can publicize the attempts, subjecting the enforcers to the usual types of reputational and other sanctions from the scientific community. Thus, a norm of sharing without patenting may evolve, for dual-purpose research tools, into a norm of ignoring research uses of patented inventions.

characteristic of dual-purpose research tools is that such tools are far from “embryonic,” at least as regards their employment in research. Thus, the arguments in favor of patenting may be relatively weak in this context. In any event, I lay that debate to the side here and discuss the potential for sharing norms to persist in the face of patenting of dual-purpose inventions.

68. The caveat that the need to obtain patent protection may occasion some delay in publication is appropriate here, however. For discussions of publication delays, see David Blumenthal et al., *Withholding Research Results in Academic Life Science: Evidence from a National Survey of Faculty*, 277 J. AM. MED. ASS'N 1224 (1997); Eric G. Campbell et al., *Data Withholding in Academic Genetics: Evidence from a National Survey*, 287 J. AM. MED. ASS'N 473 (2002); Jeremy M. Grushcow, *Measuring Secrecy: A Cost of the Patent System Revealed*, 33 J. LEGAL STUD. 59 (2004).

69. An example of commercial use of a do-it-yourself invention would be the use of a patented process in a commercial, nonresearch context. It is also reasonable to discuss commercial sales of a do-it-yourself research tool in the sense that some scientists may be happy to make their own research tools in the lab, while others may prefer to purchase a standardized tool (or expert assistance in performing a standard method) from a commercial supplier.

The desire to make commercial profits from dual-purpose inventions will also tend to induce patenting by industry researcher innovators. The result may be paradoxical: patenting dual-purpose research tools for commercial sale also forces industry scientists to disclose them and precludes secret use in an industry lab. In general, the industry research context is less conducive to sharing norms than academia because exclusivity is too easy. Because industry laboratories are closed to outsiders and many industry scientists are not required to publish in scientific journals, the costs of maintaining exclusive use of a research tool may be quite low. This means that the net benefit of exclusivity, *E*, will tend to be large for industry scientists. Even more problematic for sharing norms in the industry context is the difficulty of enforcement. Enforcing a sharing norm against an industry scientist who uses a newly invented research tool or method secretly and exclusively in his or her own laboratory would be nearly impossible.

By patenting dual-purpose research tools, industry scientists forfeit one of their most effective and inexpensive mechanisms of maintaining exclusive use of research tools they invent—secrecy. If a patented invention is a do-it-yourself tool, keeping other scientists from using it once it is patented requires costly litigation (or at least a credible threat of litigation), reducing the net benefits of exclusivity, *E*. Commercial patentees of dual-purpose research tools may thus also prefer to ignore infringing use of those innovations in research.

An “ignore patents in research use” norm has the potential to unite academic and commercial researchers into a single tool-sharing community—at least for dual-purpose do-it-yourself research tools—if it can be enforced. While the mechanisms for enforcing a norm of ignoring patents against an industry scientist are not as powerful as those available to enforce sharing within the academic research community—industry scientists rely far less on scientific reputation, publication, and often not at all on peer-reviewed funding mechanisms—the academic research community is often far from powerless. Industry scientists have many of the same preferences for participation in research that academic scientists do. They often rely on academic scientists for informal scientific discussions and even for collaboration. Perhaps most importantly, industry research departments rely extensively on their relationships with academic scientists in recruiting and hiring staff. In some cases, academic researchers also have some ability to affect a company’s public reputation.

Empirical evidence suggests that an ignore patents norm is reasonably well-established even across the academic-industry boundary, just as this analysis would predict.⁷⁰ Instead of the feared anticommons and “patent thicket” situation for do-it-yourself research tools, a norm of “ignoring patents” seems to have replaced the norm of sharing tools and not patenting. University scientists are widely known to ignore patent rights routinely.

70. Walsh et al., *Effects of Research Tool Patents*, *supra* note 8, at 324–28.

Only five percent of university scientists in a recent survey study by John P. Walsh, Charlene Cho, and Wesley M. Cohen even bother to check for patents that might cover their research activities⁷¹ despite the fact that twenty-two percent have been advised by their institutions that they should take steps to avoid patent infringement.⁷² Patents deter very few scientists from making research tools “in house.”⁷³ Despite widely publicized legal decisions sharply restraining the scope of any legal “research exemption,”⁷⁴ scientists routinely believe themselves protected by such an exemption.⁷⁵ They believe that they should not have to pay royalties for tools that they can make in their laboratories⁷⁶ and that high commercial prices for research inputs justify resorting to do-it-yourself solutions.⁷⁷ They may even purchase patented materials from unlicensed suppliers.⁷⁸ Universities refrain from asserting patents against each other under a norm of “academic use”⁷⁹ and sometimes ignore letters notifying them of the potential need to take a patent license.⁸⁰ In at least one documented case, a community of academic researchers actively advocated ignoring a research tool patent as a result of what members deemed unreasonable demands from DuPont, the exclusive licensee of the oncomouse patent.⁸¹

Consistent with the limited importance afforded to patents by scientists, Walsh, Cho, and Cohen found that only one percent of academics reported more than a one-month research delay to obtain patent licenses and none of the academic respondents had abandoned a study as a result of problems acquiring such licenses.⁸² Moreover, though the sample size for the question was small, only one of seventeen industrial researchers reported abandoning a project because of inability to license necessary research tool patents.⁸³

The norm of ignoring patents on research tools does not seem to be simply a matter of difficulty of enforcement, at least with regard to academic use. Academic laboratories are relatively accessible and have many visitors. More to the point, industry tool patentees and academic

71. WALSH ET AL., PATENTS, MATERIAL TRANSFERS AND ACCESS, *supra* note 8, at 15.

72. *Id.* at 16.

73. *Id.* at 26–27.

74. *See, e.g.,* *Madey v. Duke Univ.*, 307 F.3d 1351, 1362–63 (Fed. Cir. 2002) (finding university research ineligible for the experimental-use exemption because it “unmistakably further[s] the institution’s legitimate business objectives, including educating and enlightening students and faculty participating in these projects”); *Embrex, Inc. v. Serv. Eng’g Corp.*, 216 F.3d 1343, 1349 (Fed. Cir. 2000) (“While [the] SEC tries to cloak these tests in the guise of scientific inquiry, that alone cannot immunize its acts.”).

75. WALSH ET AL., PATENTS, MATERIAL TRANSFERS AND ACCESS, *supra* note 8, at 6; Walsh et al., *Effects of Research Tool Patents*, *supra* note 8, at 324–28.

76. Walsh et al., *Effects of Research Tool Patents*, *supra* note 8, at 324.

77. *Id.* at 324–28.

78. *Id.* at 325.

79. *Id.* at 327.

80. *Id.* at 317.

81. Murray, *supra* note 22, at 27.

82. WALSH ET AL., PATENTS, MATERIAL TRANSFERS AND ACCESS, *supra* note 8, at 2.

83. *Id.* at 36.

scientists agree that academics are known to infringe and yet are left alone.⁸⁴ Firms avoid suing nonprofit institutions for infringement in part because of the paucity of damages available, but also because they anticipate negative publicity and community sanctions if they sue, and because they believe that they will benefit from academic research, which advances knowledge relevant to their patent portfolios.⁸⁵ Moreover, one result of the increasing overlap of university and industry research is that industry scientists increasingly depend on their interactions with academic scientists to advance their own research agendas and are thus susceptible to shunning if they appear to have violated sharing norms.⁸⁶

There is also evidence that the norm of ignoring research tool patents extends to research use by industry scientists.⁸⁷ Industry scientists also report that they sometimes ignore patents on research tools.⁸⁸ Though they are much more likely than academics to check for patents and somewhat more likely to report that patents prevent them from making tools in-house,⁸⁹ only one out of seventeen industry researchers surveyed by Walsh, Cho, and Cohen reported having stopped a project because of a research tool patent. In an earlier survey, respondents noted that infringement of research tool patents by firms is “pervasive” and that people infringed “all over the place;”⁹⁰ that “scientists are not telling their patent counsel” about potential infringement;⁹¹ and that there is a sense that fighting over intellectual property rights can wait until someone has achieved a valuable research result.⁹² Industry scientists also sometimes invoke a “research exemption” based on whether the patent covers the product resulting from the research,⁹³ and firms wait to assert their patents until there is a “valuable” result.⁹⁴ Of course the tendency for industry scientists to ignore patents on do-it-yourself research tools is also consistent with the difficulties that patentees would have in detecting infringement in industry laboratories.

The distinction between commercial and research tool use of patented inventions anticipated by the sharing norm analysis is also evident in

84. *Id.* at 37; Walsh et al., *Effects of Research Tool Patents*, *supra* note 8, at 317, 324–28.

85. NAT’L RESEARCH COUNCIL, INTELLECTUAL PROPERTY RIGHTS AND THE DISSEMINATION OF RESEARCH TOOLS IN MOLECULAR BIOLOGY 63 (1997) [hereinafter NRC REPORT]; Walsh et al., *Effects of Research Tool Patents*, *supra* note 8, at 325.

86. Murray, *supra* note 22, at 27; Walsh et al., *Effects of Research Tool Patents*, *supra* note 8, at 325.

87. Walsh et al., *Effects of Research Tool Patents*, *supra* note 8, at 327–28.

88. *Id.*

89. WALSH ET AL., PATENTS, MATERIAL TRANSFERS AND ACCESS, *supra* note 8, at 36.

90. Walsh et al., *Effects of Research Tool Patents*, *supra* note 8, at 309 n.38.

91. *Id.* at 327 n.58.

92. *Id.* at 327–28.

93. *Id.* at 328.

94. *Id.* at 327.

enforcement practices.⁹⁵ Thus, industrial entities believe that it is reasonable to assert patents against an academic institution when the institution “becomes a competitor” by, for example, using the patented invention to perform diagnostic tests.⁹⁶ Academic scientists also distinguish between research and making a profit,⁹⁷ with one noting that he did not mind not being compensated financially for his invention, “but if somebody else is earning a large profit on it that seems a little wrong to me.”⁹⁸

In sum, while the precise contours have not yet been mapped out, it seems that there is a widespread sharing norm that governs those research tools and methods that have been patented and can be “homemade” in the laboratory. While it is likely that research tool patent holders do not enforce their patents in part because of difficulties in detecting infringement that takes place in laboratories away from public view, the pervasiveness of the disregard for patents, its justification in normative terms, the extent to which widespread infringement is coupled with forbearance from suit, the distinction between using a tool in research and “making a profit,” and the use of reputational and shunning penalties to enforce forbearance and sharing suggest that “ignore research tool patents” is a positive social norm enforced across the communities of academic and industry scientists. It also seems likely that many patented research tools are dual-purpose inventions, since both academic and industry scientists have much greater incentive to patent in the dual-purpose case.

2. Dual-Purpose Research Tools and Materials Sharing

The implications of dual-purpose inventions for research tool sharing norms are more complex where the transfer of materials, extensive datasets, or tacit knowledge is necessary in order for others to use a research tool innovation (and also presumably needed for others to commercialize the invention). In these cases, exclusivity arises naturally from the need for materials transfer or face-to-face knowledge transmission.

One likely consequence of having commercial as well as research uses for a material is that a commercial supplier will offer it for sale on the market. When materials developed by researchers are made widely available for commercial purchase because they have nonresearch markets, the need for direct sharing between researchers is lessened. In essence, the commercial market provides a mechanism for centralized distribution.⁹⁹ However, a true sharing practice (usually the optimal result from the

95. *Id.* at 326–28; see also WALSH ET AL., PATENTS, MATERIAL TRANSFERS AND ACCESS, *supra* note 8, at 17.

96. Walsh et al., *Effects of Research Tool Patents*, *supra* note 8, at 326–27.

97. *Id.* at 327 n.57.

98. Gerard George et al., Academics or Entrepreneurs? Entrepreneurial Identity and Invention Disclosure Behavior of University Scientists 14 (Sept. 6, 2005) (unpublished paper, on file with the Fordham Law Review), available at <http://ssrn.com/abstract=799277>.

99. Walsh et al., *Effects of Research Tool Patents*, *supra* note 8, at 321–22.

perspective of the research use of the material) would mandate transfer at the lowest possible cost. A commercial seller, on the other hand, tries to obtain the highest price. A research material may be covered by patents, which provide exclusivity, but even if it is not, the need for standardization or difficulty in reverse engineering the materials may dictate that scientists obtain the material from a single source. A supplier who has exclusive access to a material thus may be able to command a high price.

The benefits of purchasing from a commercial supplier, who provides uniform quality, simplified transactions, reduced costs of production, and so forth, may outweigh any exclusivity "tax" the supplier imposes. But in many situations, the price charged by an exclusive commercial supplier of a dual-purpose research tool will exceed the cost of supplying the materials for research use. In some cases, large additional investments must be made (and recouped) by the supplier to turn the invention from a research tool into a commercial product, raising the price as a result of improvements that are unnecessary from a research perspective. For example, expensive clinical testing might be necessary to satisfy regulatory requirements, but unnecessary to use the invention in some kinds of research.

Here again, as for do-it-yourself dual-purpose research tools, the trick to promoting a sharing norm among scientists is to separate the exclusivity premium for the commercial market from the exclusivity premium for research by finding a mechanism to disseminate the tool to researchers at cost while maintaining profits for commercial uses.¹⁰⁰ Commercializing user-developed research materials necessarily involves some type of direct transaction between a researcher innovator and a commercial supplier. That transaction may involve the transfer of patent rights, materials, data, or trade secret know-how. (If no direct transaction is needed, then there is no reason to anticipate that commercial supply will be exclusive and hence no concern about pricing above marginal cost.) The transfer from a researcher innovator to a commercial supplier provides a pressure point at which the norms of the scientific community can be enforced. For example, a sharing norm might require that academic researcher innovators transfer inventions for commercialization only under licenses that provide generous discounts for researchers. Alternatively, the license might permit face-to-face or centralized sharing mechanisms within the scientific community to continue to operate despite commercial exclusive sales. In fact, "norm

100. University researchers often do get substantial discounts on research materials. Sometimes these discounts have little to do with sharing norms among scientists. Commercial suppliers may be motivated to offer discounts on their own initiative as a form of price discrimination, given that academic scientists may have limited ability to pay. Commercial suppliers may also be susceptible to reputational penalties. Those for whom scientists are important customers can be susceptible to a "boycott" approach. Some areas of research are so important to public health or some other public concern that the public at large may protest a failure to provide research discounts. These factors may lead to academic discounts for manufacturer-developed tools.

entrepreneurs" within the academic community are advocating exactly this kind of approach.¹⁰¹

While the "ignore patents" norm seems to function effectively even across the academic-industry boundary for do-it-yourself research tools, the evidence suggests that there are particular difficulties with sharing materials across the industry-academic boundary.¹⁰² Besides sometimes failing to receive materials requested from industry suppliers, academic scientists complained of requests for onerous terms of transfer, such as reach-through royalties and publication restrictions.¹⁰³ Because empirical studies have not generally distinguished between dual-purpose and other research tools, it is not clear how often these difficulties in sharing materials across the academic-industry boundary are related to concerns about protecting commercial applications of dual-purpose research tools and how often they are due instead primarily to a mismatch of sharing preferences between academic and industry scientists as discussed in the next section.

Industry scientists are not generally permitted to avail themselves of mechanisms that give academics access to research materials, such as research discounts or centralized material depositories, which are generally limited to use in nonprofit research. One reason for the limitations may be that it is more difficult in these cases to ensure a separation between research use and commercial exploitation. There may be concern that a dual-purpose research material transferred to an industry scientist at nominal cost will be used for commercial purposes beyond research. In fact, in some cases, such as those involving physicians who wear both researcher and clinician hats, even academic discounts pose difficult line-drawing problems and blur the boundary between commercial and research use.¹⁰⁴

Patenting is in principle a means to diminish some of the potential for leakage from research use to commercial exploitation because patents can be used to enforce restrictions to research use only. This paradoxical role of patents may explain, in part, the finding by Walsh, Cho, and Cohen that the friction involved in sharing research materials is not increased by patenting. The remaining difficulties in sharing research materials across the academic-industry boundary suggest, however, that worries about mixing commercial and research uses of dual-purpose materials may continue to depress the potential for sharing of research materials between industry and academic scientists.

101. See *supra* note 100.

102. WALSH ET AL., PATENTS, MATERIAL TRANSFERS AND ACCESS, *supra* note 8, at 25, 35–36; Murray, *supra* note 22, at 25.

103. WALSH ET AL., PATENTS, MATERIAL TRANSFERS AND ACCESS, *supra* note 8, at 23–25, 35. When materials were transferred to academic scientists, however, up-front fees were rare and almost never more than \$1000.

104. David C. Mowery & Arvids A. Ziedonis, *Academic Patents and Materials Transfer Agreements: Substitutes or Complements?*, 32 J. TECH. TRANSFER 157 (2007).

The arguments in this section are summarized in Table II. To evaluate the relationship between dual-purpose research tools and sharing practices further, it would be helpful to know how many research tool patents are actually patents on dual-purpose innovations, the extent to which difficulties with sharing materials arise in the dual-purpose context, and so forth.

B. *The Implications of Overlapping Academic and Commercial Research Communities*

Besides the role played by dual-purpose inventions, the other major ramification of research in Pasteur's Quadrant is that the relevant research community no longer consists only of academic scientists. In the Walsh, Cho, and Cohen study, thirty percent of academic respondents had ties to small businesses and twenty percent to large firms.¹⁰⁵ Industry scientists often collaborate with large numbers of academic scientists as well. Because industry scientists have a different typical preference profile from academic researchers and work in a very different environment, it is more difficult to stabilize and enforce norms of sharing in a community consisting of both academic and industry scientists than in a more homogeneous academic research community. The question thus arises to what extent research tool sharing norms can survive in a mixed scientific community. Furthermore, the social benefits of research tool sharing are less clear when industry scientists are involved since they are more likely to keep their research results secret. Thus, there is a question to what extent policy should aim to promote sharing academic research tool innovations with industry scientists as opposed to simply maintaining sharing practices between academics.

1. Differences Between Industry and Academic Scientists

Typical differences between academic and industry scientists can be incorporated into the social norm model discussed earlier by adjusting the parameter values. Unlike academic researchers, who report scientific competition and sharing costs as the major impediments to sharing materials, industry researchers report protecting commercial value and inability to obtain desired licensing terms (probably also related to commercial competitiveness) as by far the most important reasons not to share.¹⁰⁶ Industry scientists will generally have a greater ability to benefit from exclusive use of a tool or method, (higher E in the model) in part because, at least outside of the dual-purpose invention context, they can more easily keep tools or methods secret while using them within their laboratories and in part because they may be able to obtain greater exclusive benefits from their research results. Also, since they work for entities

105. WALSH ET AL., PATENTS, MATERIAL TRANSFERS AND ACCESS, *supra* note 8, at 11.

106. *Id.* at 55 fig.2.

motivated primarily by the potential for commercial gain, rather than by the intrinsic pursuit of knowledge, they are less able to benefit from the success of the research enterprise as a whole than academic scientists (lower U in the model). For similar reasons, industry scientists may obtain smaller rewards for sharing their research tool innovations through publication or otherwise (lower R). This means that a group of industry scientists is generally less likely than a group of academic scientists to be in regimes I or II of the model where sharing is optimal.

Nonetheless, the user innovation analysis suggests that sharing will be preferable even among industry research entities in some circumstances, just as it has sometimes been in other commercial settings. For example, players in the biotechnology “industry”—or at least certain parts of it—might value the overall success of the industry in its competition with other approaches to medical, agricultural, and other life science-related technological problems more than they value exclusive use of a research tool. Earlier studies of information sharing among commercial entities suggest that sharing is most likely to be preferred during a period in which an industry is being established¹⁰⁷—certainly the situation for many research-intensive science-based commercial entities. Commercial entities may also find it worthwhile to cooperate in producing certain platform tools, while competing to produce results using them. Commercial support for open source software is of this ilk.

Even if sharing at least some tools and methods would be preferable for industry researchers, however, they may have difficulty overcoming the collective action problems of Regime II with social norms because it is difficult to enforce a sharing norm for research tools in the industry environment, where trade secrecy is generally feasible (so that it is hard to detect failures to share) and where scientists may not have the repeated interactions and relationships that facilitate community-imposed sanctions. Industry groups that have developed sharing norms historically seemingly have relied on personal relationships, opening their facilities to visits from competitors, movement of personnel within the industry, and publications to develop the means to enforce them.¹⁰⁸ When industry scientists publish their methods, discuss them at conferences, or share them with trusted friends at other companies, this is evidence of the kinds of relationships that might support a sharing norm. Occasional publication is not a guaranteed means of detecting failures to share, however, since it is difficult to assess what a firm might be holding back.

While it may be possible in some arenas to develop informal sharing arrangements across the academic-industry interface, there are significant

107. Meyer, *supra* note 4, at 15–17.

108. *Id.* at 2–3; see also NAT'L ACAD. OF SCI., NAT'L ACAD. OF ENG'G, INST. OF MED., OBSERVATIONS ON THE PRESIDENT'S FISCAL YEAR 2003 FEDERAL SCIENCE AND TECHNOLOGY BUDGET (2002); Arti K. Rai, “Open and Collaborative” Research: A New Model for Biomedicine, in INTELLECTUAL PROPERTY RIGHTS IN FRONTIER INDUSTRIES: SOFTWARE AND BIOTECHNOLOGY 131, 131–59 (Robert W. Hahn ed., 2005).

barriers to doing so: industry scientists are likely to be both more motivated and more able to defect from sharing norms than academics. The situation for an overlapping community of industry and academic researchers engaged in Pasteur's Quadrant research is thus quite complicated. If a sharing norm would be viable in each community separately, a combined community would probably also prefer to share, but even in such cases mechanisms for sharing and for enforcing sharing norms will have to be adapted to a more heterogeneous group. Except when dual-purpose innovations are involved, the closed industry context means that there is no guarantee that a sharing practice can be established. Industry scientists will often be able to defect with impunity by simply keeping their tool innovations secret and will not be able to commit credibly to a sharing practice. Moreover, the fact that industry scientists may want exclusive rights over their research *results* may make sharing research tools with them less attractive to academics.

Nonetheless, even if sharing across the academic-industry boundary is difficult, there is no reason to assume that the overlap of industry and academic research will lead inexorably to a breakdown of sharing norms among academics. Sharing norms that existed among academic scientists during a period when there was less overlap between academic and industry research reflected the preferences of academic scientists, as we have discussed. Unless the overlap between research agendas radically affects those preferences themselves, the academic science community can be expected to "defend" its research tool commons. If, as may well be the case, sharing is preferred by academics but not by industry scientists, or if a joint sharing norm cannot be enforced, academics can adopt a different type of tactic. Rather than attempt to maintain a joint practice of sharing research tools and materials with industry scientists, academic scientists may attempt to "police the boundaries" of their research tools commons by sharing with other academics and not with industry scientists.

If academics can do this effectively, academic and industry research entities can then engage in tit-for-tat exchange or market transactions across the boundary between their communities. Paradoxically, then, an academic research tool commons that excludes industry researchers might actually increase the total amount of research tool sharing since industry researchers will have to cough up something (either money or access to their own innovative tools) in exchange for access to academic research tool innovations. As we saw in the dual-purpose context, accommodating the need to exchange research tools, methods, and materials with "outsiders" may require adapting sharing mechanisms within the academic community. New opportunities for academics to defect from sharing norms by making side deals with industry players may also have to be taken into account in norm enforcement practices in Pasteur's Quadrant. Increased academic intention to conflict of interest policies is one way to deal with this problem.

Critical factors in determining what will happen when academic and industry research streams merge are whether or not each group of researchers can control the other group's access to the tools it has developed and whether each group has means of detecting and penalizing defections from its norms. These factors operate differently depending on whether one focuses on do-it-yourself tools and methods or on materials, data, and tacit knowledge.

2. Sharing Norms for Do-It-Yourself Research Tools in Pasteur's Quadrant

In academic science, as discussed, do-it-yourself research tools and methods are traditionally shared by publication. Within the academic research community, a norm of sharing through publication can be enforced because the community enjoys considerable control over the allocation of research funds and reputation through peer review and so forth, and university labs are open enough that violations of the norm are reasonably likely to be detected if a tool is not disclosed within a reasonable period of time. Control of these resources can be used to penalize noncompliance with the sharing norm.

Given this open publication model, however, the academic community has relatively weak mechanisms for controlling the access of industry scientists to published do-it-yourself tools and methods. Industry scientists may not depend strongly on public funding¹⁰⁹ and may have little sensitivity to reputation penalties imposed by the academic community. And, as already discussed, unless industry scientists are independently motivated to patent their tools and methods (as they would be for dual-purpose inventions), it would be difficult to monitor whether industrial researchers are complying with a sharing norm by publishing their own tools and methods. A likely outcome of the merging of academic and industrial research streams is that industry researchers make free use of do-it-yourself tools and methods developed by academic researchers while keeping their own tool innovations to themselves.

This may or may not be a problem from a social perspective. After all, technology transfer is all about making academic inventions, funded with public money, available for commercial purposes.¹¹⁰ From the perspective of the academic research community, however, academic scientists' inability to trade their tool inventions for access to tools invented by industry scientists raises a kind of reverse technology transfer problem. Academics would like to gain access to research tools developed by industry scientists and would therefore prefer to use their own research tool

109. I say "may" here because some industry scientists do rely significantly on public funding, though the scientific community may not control that funding through peer review.

110. MOWERY ET AL., *supra* note 63, at 1; Joel West & Scott Gallagher, *Patterns of Open Innovation in Open Source Software*, in OPEN INNOVATION: RESEARCHING A NEW PARADIGM 82 (Henry Chesbrough et al. eds., 2006).

inventions as “bargaining chips” for this purpose, while maintaining a sharing norm among academics.

Patenting is one means to try to distinguish industry and academic research use—just as patents can be used to distinguish between research use and other commercial use. Enforcement of patents on do-it-yourself research tools and methods against industry scientists working in closed laboratories is likely to be ineffective, however. Industry scientists are likely to be able to “free ride” on academic do-it-yourself research tool inventions with impunity—and without disclosing their own research tool innovations.

Interestingly, academic-industry collaboration, which may be worrisome in light of its potential effects on the *direction* of academic research,¹¹¹ may increase the potential for sharing between academic and industry scientists because it gives the academic community leverage to impose reputational and shunning penalties on industry researchers, and gives academic researchers greater ability to “monitor” industry sharing of tools and methods. It is very difficult to assess the functioning of industry-academic sharing norms for do-it-yourself research tools, since, outside of the context of dual-purpose research tools, it is hard to know what fraction of industry-developed tools are patented, published, or otherwise disclosed so as to make them publicly known. The analysis in this section is summarized in Table III.

3. Materials Transfer in Pasteur’s Quadrant

Where dissemination of research tools and methods requires not only publication, but also the transfer of materials, data, or tacit knowledge, the situation is somewhat different. In this kind of situation, though industry scientists can continue to keep their own tools secret, they cannot simply free ride off of academic sharing norms. Moreover, sharing with industry scientists becomes more costly to academic researcher innovators, who are likely to be unwilling to share without receiving something in return. Thus, while the need for materials transfer complicates the establishment of sharing norms between academics because it increases the cost of sharing (and thus may undermine sharing norms), the natural exclusivity available in this situation may help to facilitate either the enforcement of sharing norms across academic-industry boundaries or at least the development of a

111. Henry Etzkowitz, *The Evolution of the Entrepreneurial University*, 1 INT’L J. TECH. & GLOBALISATION 64 (2004); Tomas Hellström & Merle Jacob, *Emerging Issues in R&D Evaluation: The Case of University-Industry Partnership Networks*, in THE FUTURE OF KNOWLEDGE PRODUCTION IN THE ACADEMY 95 (Merle Jacob & Tomas Hellström eds., 2000); Merle Jacob & Tomas Hellström, *From Networking Researchers to the Networked University*, in THE FUTURE OF KNOWLEDGE PRODUCTION IN THE ACADEMY, *supra*, at 81; James Stuart, Comment, *The Academic-Industrial Complex: A Warning to Universities*, 75 U. COLO. L. REV. 1011 (2004); Waverly Ding, *Does Science Chase Money?—The Impact of Industry Research on the Selection of Research Topics Among Academic Scientists* (n.d.) (unpublished study, on file with the Fordham Law Review).

barter or market mechanism for exchanging research tools between industry and academic scientists.

When academic scientists take measures to reduce the costs of sharing by developing collective materials depositories, for example, they often confine access to those repositories to academics.¹¹² The first-best option from a social perspective might be for both academic and industry scientists to participate in a joint materials depository. However, it is difficult for an industry scientist to make a credible commitment to contribute to the depository because industry secrecy makes it difficult to tell whether she is actually contributing her innovative materials. Even if these enforcement problems could be solved by monitoring and balancing contributions and use of materials, the preference differences and difficulties in enforcing sharing between academic and industry scientists may still preclude a viable joint pool of research materials. A more feasible second-best option may therefore be a pool of research materials restricted to academics supplemented by individual tit-for-tat or market exchanges with industry scientists.

Table IV summarizes this analysis. Given this analysis, the need to rely on individually negotiated transactions rather than informal norms might be expected to lead to friction at the boundary between the academic and industry scientific communities. Indeed, these are the most problematic transfers. Where a formal material transfer was involved, sixty percent of transfers from academia to industry took more than one month to negotiate, compared to forty-five percent of transfers from industry to industry;¹¹³ while thirty-five percent of transfers from industry to academia took more than one month to negotiate, compared to twenty-one percent of transfers between academic institutions.¹¹⁴ Moreover, while attempts to standardize a formal material transfer agreement with minimal restrictions have been moderately successful in the academic context (many institutions use the Uniform Biological Materials Transfer Agreement), attempts to develop a minimally restrictive uniform agreement to cover material transfers from industry to academia have failed.¹¹⁵ It is difficult to know, however, whether the friction at the academic-industry boundary is part of a healthy defense of an academic research tool commons or merely a symptom of norm failure.

112. SCOTT STERN, *BIOLOGICAL RESOURCE CENTERS: KNOWLEDGE HUBS FOR THE LIFE SCIENCES passim* (2004) (detailing the history, impact, and future of biological resource centers).

113. WALSH ET AL., *PATENTS, MATERIAL TRANSFERS AND ACCESS*, *supra* note 8, at 35–36.

114. *Id.* at 25.

115. Eliot Marshall, *Need a Reagent? Just Sign Here . . .*, 278 *SCIENCE* 212, 213 (1997); Mowery & Ziedonis, *supra* note 104, at 161.

III. THE POTENTIAL TO PROMOTE SHARING IN PASTEUR'S QUADRANT THROUGH LAW AND POLICY

Tables I through IV in the Appendix attempt to summarize the analysis presented in this essay. Three primary factors determine the feasibility of sharing norms and practices for user-developed research tools: (1) the divergent preferences of academic and industry scientists, which determine whether sharing is preferred by scientists themselves; (2) the differences in potential for exclusivity and cost of sharing between do-it-yourself research tools and tools that require face-to-face transactions such as research materials; and (3) the distinction between garden variety research tools and dual-purpose research tools that have significant commercial markets outside of the research context. In this part, I rely on the above analysis to consider whether policy measures can promote wider sharing of research tools and materials in Pasteur's Quadrant.

A. *Promoting a Do-It-Yourself Research Tool Commons*

In Pasteur's Quadrant, do-it-yourself tools are likely to be widely shared, with the exception of garden variety research tools developed by industry scientists, which can be kept secret. Academics will share do-it-yourself tools with each other and, unavoidably, with industry scientists through the traditional mechanism of publication. They may use patents to restrict the commercial exploitation of dual-purpose do-it-yourself tools, but are unlikely to employ patents against other researchers because they value shared access to tools developed by others. Industry scientists will necessarily disclose their dual-purpose research tools if they patent them, as they will try to do in order to exploit the nonresearch commercial market. While they could in principle seek to enforce those patents against other researchers, they are unlikely to do so (as evidenced by the "ignore patents" norm) because of the difficulty of enforcement in comparison to the benefits of a norm of sharing for research use.

A widespread norm of sharing do-it-yourself research tools is thus to be expected, and the failure of empirical studies to find problems with patenting of research tools per se is understandable in this framework. However, the benefits of sharing research tool innovations are unlikely to induce industry scientists to share their garden variety research tools, which they can use secretly in their laboratories. There is little that can be done to induce industry scientists to share such tools since academics have no way to prevent industry scientists from using the research tools that academics develop and publish.

If, as it seems, the "ignore patents" norm is already functioning to permit sharing in the do-it-yourself research tool context except when industry scientists can keep their research tools secret, one approach is to let well enough alone. There are several reasons that we might want to do more to encourage research tool sharing, however, by codifying the "ignore patents" norm in a legally enforced research use exemption from patent infringement

and by discouraging academics from patenting garden variety do-it-yourself research tools. First, sharing of research tools leads to faster research progress, which has social benefits over and above its payoffs to researchers themselves. Exclusive use of research tools has little if any public benefit. Thus, society may want to promote sharing even when scientists themselves prefer exclusivity. While the “ignore patents” norm suggests that scientists generally do prefer to share do-it-yourself tools, a research use exemption would stabilize the norm in marginal cases and against defectors.¹¹⁶

Moreover, the norm could erode in the future. Even though patents facilitate the separation of commercial and research exclusivity, commercialization of dual-purpose innovations by academic scientists has the potential to lessen that community’s ability to impose penalties on defectors from the sharing norms. Academic scientists’ preferences for doing research might change through their involvement in commercializing a dual-purpose invention, for example, or, perhaps more importantly, the availability of alternative sources of both financial and psychological income might decrease the force of reputational penalties from the community on those scientists who invent dual-purpose research tools.

Policy initiatives by research funders and by norm entrepreneurs within the research community can also bolster the norm of not enforcing patents against research users of dual-purpose research tools. For example, the recent White Paper, *In the Public Interest: Nine Points to Consider in Licensing University Technology*, signed by a number of universities, advocates a distinction between licensing for sale and licensing for use, proposing that “[a]bsent the need for a significant investment—such as to optimize a technology for wide use—broad, non-exclusive licensing of tools . . . can help maximize the benefits.”¹¹⁷ Further, the White Paper states that “drafting of [an] exclusive grant could make it clear that the license is exclusive for the sale, *but not use*, of such products.”¹¹⁸ As the White Paper points out, “in [drafting a license which is exclusive only for sale], the university ensures that it is free to license non-exclusively to others the right (or may simply not assert its rights) to use the patented technology, which [researchers] may do either using products purchased from the exclusive licensee or those that they make in-house for their own use.”¹¹⁹ More initiatives of this sort, including perhaps making research funding contingent on research use exemptions in licenses,¹²⁰ would be desirable to strengthen research use sharing norms against possible

116. See Strandburg, *supra* note 3, for a discussion of the effects of a research-use exemption on tool suppliers.

117. ASS’N OF AM. MED. COLLS. ET AL., *IN THE PUBLIC INTEREST: NINE POINTS TO CONSIDER IN LICENSING UNIVERSITY TECHNOLOGY* 3 (2007), available at <http://news-service.stanford.edu/news/2007/march7/gifs/whitepaper.pdf>.

118. *Id.*

119. *Id.*

120. Rai, *Regulating Scientific Research*, *supra* note 9, at 147.

temptations to defect. Licensing practices play an even more important role in promoting sharing of research materials, to which we now turn.

B. *The More Complicated Arena of Material Transfer*

Research materials have higher sharing costs and lower costs to enforce exclusivity, so on balance they are less likely to be shared. However, in the academic context, at least, norms of materials sharing remain relatively strong, and there are steps that can be taken, primarily by reducing the costs of sharing materials, to strengthen those norms. These steps include establishing centralized materials depositories, establishing a norm that dual-purpose research tool licenses include academic research discounts or rights to distribute the materials through research depositories, and standardized nonrestrictive terms for materials transfer agreements.¹²¹

Assuming that some or all of these mechanisms to enhance the viability of academic research materials sharing norms are adopted, the question raised by the analysis in Part II.B is to what extent such initiatives to promote sharing can and should be extended to industry scientists. There are two distinct strategies one might adopt for optimizing sharing in Pasteur's Quadrant: one approach is to attempt to encompass both industry and academic scientists within a single materials sharing community. An alternative is to exclude industry scientists from an academic research materials commons so that they cannot free ride off of academic sharing norms, but must exchange something—such as access to their own research materials—for access to the academic materials commons.

Where industry scientists can keep their own innovations secret—as they can for garden variety research tools—a joint sharing approach is unlikely to work. There might be some situations in which it is possible to monitor industry contributions to and withdrawals from a jointly accessible materials depository or other research tool commons so as to ensure a proper balance over time. In most cases, however, it will probably be too easy for industry participants to game the system and hold back their most important innovations. For the most part, then, the best approach to garden variety research materials is probably for academic scientists to engage in tit-for-tat or market transactions with industry scientists seeking access to their research material innovations.

To do this, academic researchers must have something to exchange, which means that, if there is to be a research tool and material commons for academic researchers, it must be limited to academic researchers so that the tools and materials can be used as currency of exchange with outsiders. It is thus interesting to note that most of the mechanisms for enforcing materials sharing within the academic community do reserve access to members of that community. Licensing terms with noncommercial research exemptions, noncommercial materials repositories, and so forth

121. Strandburg, *supra* note 7 (manuscript at 1).

reduce the advantages to academics of defecting, while at the same time restricting the advantages of common access to noncommercial researchers. Norm entrepreneurship within the academic community aimed at presenting a united front in dealing with industry also serves both ends.¹²² For example, the “Nine Points” issued recently by a group of universities and discussed above urges universities to negotiate all licenses, even those involving industry, so as to reserve rights for all nonprofit organizations “to transfer tangible research materials . . . to others in the non-profit and governmental sectors.”¹²³ Research funding agencies could promote similar policies.

The situation might be different for dual-purpose research tools. The usual concern about industry scientists—that they will use tools from a research commons while keeping their own tools secret—is ameliorated for dual-purpose tools, which are likely to be exploited commercially and hence disclosed. Industry scientists could thus feasibly participate in a joint depository for dual-purpose research materials as long as they commit to making their own commercially available or patented materials available to other researchers through the depository. On the other hand, industry scientists will often keep their research *results* secret, which may or may not provide reason to exclude them from a research tool commons. (The propensity to keep research results secret reduces the social spillovers from making research tools more widely available.)

CONCLUSION

The analysis presented in this essay is necessarily somewhat abstract, in part because empirical studies have only recently begun to focus on the distinction between do-it-yourself research tools and materials and generally have not yet focused on the distinction between dual-purpose and garden variety research tools. More empirical information about how sharing practices depend on these distinctions and about the industry and academic preferences that determine the parameters in our model would be valuable for refining both the analysis and the proposals here.

A few summary comments are nonetheless in order. First, the analysis of preferences and social norms points out that scientific interest in the same research questions does not immediately transform industry and academic researchers into one scientific community. Different preference structures and relationship patterns may support separate community norms and practices despite overlapping research. Second, because academic researchers are more likely both to prefer and to be able to maintain sharing norms, the possibilities for beneficial sharing norms and practices may somewhat paradoxically depend on maintaining separate preference structures and norms in industry and academia even when there are overlapping research interests. This observation may have implications for

122. Murray, *supra* note 22, at 36.

123. ASS'N OF AM. MED. COLLS. ET AL., *supra* note 117, at 2.

university policies regarding faculty entrepreneurship and conflicts of interest.

Finally, this analysis should encourage efforts to find ways to make research tool sharing more attractive and less costly to both groups. Scientific journals are a particularly promising point of contact between academic researchers and those industry researchers who benefit from the overall advancement of a particular field. While it is probably not possible to reduce the private commercial benefits of exclusivity, mechanisms for reducing the cost of materials transfer both enhance the benefits of sharing for the entire group and reduce individual incentives to defect, making it more likely that both industry and academic scientists will be willing to participate in broad-based research tool sharing.

APPENDIX¹²⁴

Table I: Dual-Purpose Research Tools & Do-It-Yourself Transfers

Transfer	Dual-Purpose Research Tools (Disclosure needed for commercial exploitation by both industry and academic scientists so secrecy is not an option; patenting is likely for commercial exploitation)		
	Likely Community Preference	Viability of Sharing Norm/Practice	Policy Recommendation
A ↔ A	Share: <i>U</i> high; <i>E</i> low	High: Traditional communalism	None
I → A A → I	Probably share: <i>E</i> low for both; <i>U</i> higher for academics	Medium: Hard to detect industry infringement; reputation penalties for suing academics; ignore patents norm	Research use exemption
I ↔ I	Probably share: <i>E</i> low due to difficulty of enforcing patents on DIY research use; <i>U</i> may not be high	High: Hard to detect infringement of DIY research tool patents	Research use exemption

124. In the tables included in this appendix, "A" stands for academic scientist, and "I" stands for industry scientist. An extended discussion of sharing between academics (A ↔ A) may be found in Strandburg, *supra* note 7.

Table II: Dual-Purpose Research Tools & Materials Transfers

Transfer	Dual-Purpose Research Tools (Disclosure needed for commercial exploitation by both industry and academic scientists so secrecy is not an option; patenting is likely for commercial exploitation)		
	Likely Community Preference	Viability of Sharing Norm/Practice	Policy Recommendation
A ↔ A	Share if costs can be decreased: <i>U</i> high; <i>E</i> low if can separate commercial and research exclusivity; <i>C</i> can be high	Medium: Depends on mechanisms to bring sharing costs down	Research use exemption; UBMTA; ¹²⁵ depositories; commercial licensing with research-friendly terms
I → A A → I	Possibly share: <i>E</i> higher for industry; <i>U</i> higher for academics; concerns about separating commercial and research use, but patents mitigate; concerns about industry secrecy of research results	Medium: Different academic and industry preferences may undermine sharing norms; decreasing costs of sharing would help	Research exemption; reduce sharing costs (e.g., UBMTA-like terms; joint depositories with strict requirements for contributions)
I ↔ I	Possibly share: <i>E</i> may be high; concerns about separating commercial and research use, but patents mitigate; <i>U</i> may be low depending on state of industry	Low to medium: In many cases preferences will be not to share (<i>E</i> too high, <i>U</i> too low); but sometimes an industry may prefer a shared platform of tools with which to compete	Research exemption; reducing sharing costs may help; need to consider antitrust issues

125. "UBMTA" stands for the Uniform Biological Material Transfer Agreement.

Table III: Garden Variety Research Tools & Do-It-Yourself Transfers

Transfer	Garden Variety Research Tools (Industry scientists may use these secretly)		
	Likely Community Preference	Viability of Sharing Norm/Practice	Policy Recommendation
A ↔ A	Share: <i>U</i> high; <i>E</i> low	High: Traditional communalism	None
I → A A → I	A prefers to share, but I may not: <i>E</i> low for academics and high for industry scientists; <i>U</i> high for academics and lower for industry scientists	Mixed: Academics will share through publication; industry can free ride on academic disclosure without reciprocal disclosure; limited ability to restrict industry use through patents	Academics should not patent; research use exemption (only mildly effective since industry use can be secret)
I ↔ I	Probably share: <i>E</i> high due to secrecy possibility; <i>U</i> may not be high	Low: Even if sharing is preferred, no way to enforce because of secrecy	None

Table IV: Garden Variety Research Tools & Materials Transfers

Transfer	Garden Variety Research Tools (Industry scientists may use these secretly)		
	Likely Community Preference	Viability of Sharing Norm/Practice	Policy Recommendation
A ↔ A	Share if costs can be decreased: <i>U</i> high; <i>E</i> low; <i>C</i> can be high	Medium: Depends on mechanisms to bring sharing costs down	No patenting or ignore patents; research use exemption; UBMTA, depositories, commercial licensing with research-friendly terms
I → A A → I	Possibly share: <i>E</i> high for industry due to secrecy; <i>U</i> higher for academics; concerns about industry secrecy of research results	Low: Different preferences undermine sharing; industry secrecy undermines sharing; industry cannot free ride on academic disclosure because of need for face-to-face transactions; market or barter may be best approach	Encourage academic research material sharing (as above); joint depositories with contribution requirements and extraction limits may work in some cases; UBMTA-like standard terms with rights for academic research
I ↔ I	Probably not share: <i>E</i> may be high; <i>U</i> may be low depending on state of industry	Low: Preferences often not to share (<i>E</i> too high, <i>U</i> too low); sometimes an industry may prefer sharing tools to compete with outsiders, but secrecy permits free riding	None