**Sharing in the Shadow of Property:**
**Rational Cooperation in Innovation Markets**

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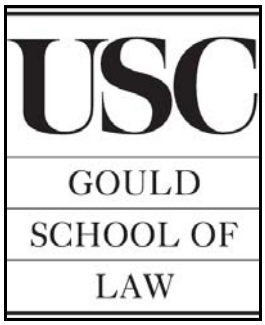


# CENTER IN LAW, ECONOMICS AND ORGANIZATION RESEARCH PAPER SERIES

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# Sharing in the Shadow of Property:
# Rational Cooperation in Innovation Markets

**Jonathan M. Barnett***

## Abstract:

*Intellectual property rests on a simple incentive rationale: without imitation barriers, innovators rationally decline to invest. But this blanket proposition is incompatible with markets where innovation proceeds without substantial recourse to intellectual property and imitation is widespread. This discrepancy sometimes drives the alternative view that intellectual property or other access barriers often or even usually are not prerequisites for intellectual production. But "utopian" understandings oversimplify the complex incentive structures and circumscribed conditions under which some markets can induce innovation without intellectual property or practical equivalents. A simple rational-choice framework anticipates that "sharing regimes"—that is, innovation environments bereft of exclusionary barriers but governed by reputational norms—can sustain a viable habitat for innovation but inherently deteriorate as endowment heterogeneity, group size, asset values and capital intensities increase. Empirics substantially track theory: industries that sustain innovation without robust intellectual-property protections tend to be confined to "low-stakes" settings or make indirect recourse to other exclusionary instruments. Critically, however, it is also the case that voluntarily-formed sharing arrangements pervade even economically-intensive markets. Properly understood, these sharing arrangements do not substitute for property but provide a vital complementary mechanism that alleviates the transaction-cost burden of an exclusionary regime. Examination of three "best cases" for the view that intellectual production can proceed without intellectual property—premodern craft guilds, academic research and open-source software—supports this intermediate position: sharing practices proliferate to facilitate the low-cost circulation of knowledge assets but are consistently embedded within a legal or technological infrastructure that implements some barrier to imitation.*

Standard economic theories of intellectual property rely on the following well-known assumption: without intellectual property or some other barrier to imitation, innovators will rationally decline to place time, capital and other resources at stake. But this blanket proposition is incompatible with the observation that innovation proceeds even where intellectual-property protections are weak or absent and imitation is rampant. Copyrights over music are routinely violated, yet music production does not cease or slow; software is widely pirated or voluntarily released with minimal or no protections against copying, yet product releases continue apace; property rights over scientific theories and other findings are virtually nonexistent, yet research proceeds forward relentlessly; and so on. These observations commonly form the basis for what I will call the "utopian thesis": namely, contrary to the incentive-based rationale for intellectual property, imitation is often *not* a barrier to innovation, which implies in turn that intellectual-property rights (or other practically-equivalent access limitations) impose a socially-unjustified tax in some important class of innovation markets. Casually formulated, typical expressions in this vein run along the following lines: "Pythagoras, Galileo and Shakespeare didn't have intellectual property but were really creative, so . . ." or "magicians, tattoo artists and hair stylists don't use intellectual property but are really innovative, so . . ." In a period when novel technologies have drastically lowered the costs of copying, compiling and distributing informational goods, and intellectual-property or other exclusionary barriers can appear to be an outdated roadblock to the almost-frictionless exchange of creative and other intangible goods, the various slogans that advance variants of the utopian thesis ("free culture", "free software", "free science", etc.) are inherently attractive, pervade popular discourse and have made substantial inroads in legal scholarship on intellectual property.

But complex facts deserve complex, not simple, interpretations. I have observed elsewhere that a monolithic property-rights view is unsatisfactory insofar as it fails to account for innovation markets[1] that proceed vigorously without intellectual-property

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protections and in the face of widespread imitation.[2] But, absent wholesale reliance on a thoroughly altruistic model of human behavior, it would be myopic to adopt the polar view that innovation can typically proceed vigorously without *some* robust barriers against imitation. Contrary to the general tenor of utopian commentary, it is vital to recognize that reconciling large-scale environments of free appropriation—what I call "sharing practices"—with rational-choice models of innovation investment is a complex analytical task that necessitates identifying an incentive structure that necessarily must (and, as I show, usually *does*) rest on an "appropriation platform" consisting of a mix of legal, extralegal and/or other technological barriers to third-party access, which in turn supply excludable revenue streams that support innovation incentives in a manner that is *ultimately* consistent with the standard incentive-based framework. Hence, what I call the "utopian mirage": any market that *apparently* sustains capital-intensive levels of innovation investment in the absence of robust intellectual-property protections—and, as will be shown, even *premodern* markets that do so virtually entirely!—is necessarily and actually supported by *some* combination of legal, extra-legal and/or technological instruments that limit access to *some* portion of the bundle of products and services.

If it is to be a meaningful proposition, the utopian thesis must be understood to hold that there exist a large number of economically-significant settings where innovation can be sustained without intellectual property or exclusionary equivalents. To identify preliminarily the circumstances under which innovation could plausibly be supported in an environment characterized by zero or weak property-rights protections, I design a hypothetical "sharing regime"[3] that relies on reputation-driven social norms that support innovation incentives even in the absence of barriers to imitation. In this hypothetical construct, all participants make contributions to and withdrawals from a common "innovation pool" in conformity with reputational norms that reward contributions to, and penalize withdrawals from, the pool, thereby generating an approximately reciprocal exchange of knowledge assets over time and avoiding the underprovision outcome that

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[1] By "innovation markets", I refer to markets or market segments principally or substantially consisting of intangible goods in the form of creative or technological products or processes.

[2] *See* Jonathan M. Barnett, *Shopping for Gucci on Canal Street: Reflections on Status Consumption and the Incentive Thesis,* 91 VA. L. REV. 1381 (2005) [henceforth Barnett, *Shopping for Gucci*].

[3] My specific understanding of this term, as distinguished from some related terms in the literature, is fully described subsequently, see *infra* note [13].

normally results in the absence of exclusionary protections. Relative to a law-based regime that relies on formal property rights to sustain contribution incentives, this norm-based regime has a great advantage: absent access barriers to the innovation pool, it avoids the substantial transaction costs that attend the creation, exchange and transmission of intellectual assets under a formal property-rights regime. But the social savings from reduced transaction costs must be "paid for" with the social losses from limited enforcement power: reputation-driven norms exert no regulatory force against "one-shot" players that have no rational interest in accumulating reputational capital and, consistent with the extensive theoretical, experimental and empirical literature on the private provision of public goods, can be expected to exhibit declining regulatory force as any relevant market exhibits increased "endowment heterogeneity" (i.e., innovation talents and capacities), group size, asset values and capital-intensity requirements.[4]

In short: as markets mature and grow in diversity, size, scale and value, sharing regimes *necessarily* tend to become an obsolete technology for inducing innovation investment. Contrary to burgeoning "IP-skeptical" and "IP-rejectionist" currents in recent scholarly, advocacy and popular commentary, this proposition anticipates few if any economically intensive markets that both sustain innovative output and are free from property-rights protections or practically-equivalent exclusionary instruments. This is a positive, *not* a normative proposition: assuming the innovator population rationally acts subject to payoff-maximization constraints, it simply *is* the case that certain specified factors will drive firms or individuals to abandon sharing regimes for more securely shielded environments in order to recoup product development costs. To assess the empirical strength of these theoretical expectations, I provide a novel survey of existing evidence concerning legal and extralegal appropriation instruments that operate in markets where innovation proceeds subject to weak or substantially incomplete intellectual-property protections. This exercise demonstrates virtually the converse to the utopian view: each market that sustains economically significant innovation investment without active adoption and enforcement of formal intellectual-property rights is *always* allied to some other legal or extra-legal instrument that provides some shield against third-party appropriation. Sharing regimes that *apparently* make little or no use of formal exclusionary instruments to secure innovation returns strongly *support* this thesis: bereft

[4] Each of these terms are defined in greater detail subsequently. *See infra* Part __.

of any meaningful obstacles to imitation, these markets tend to be confined to technologically primitive markets with low capital-intensity requirements where innovators have relatively insubstantial investments at risk. Innovation behavior tends to conform to theoretical expectations: while reputation-driven norms are a *feasible* substitute for intellectual-property protections as an instrument for sustaining innovation incentives in "low-stakes" settings characterized by low numbers (or large numbers organized into collective groups), low endowment heterogeneity, low capital-intensity levels and low asset values, these generally are not a *stable* substitute in "high-stakes" settings characterized by high numbers, high endowment heterogeneity, high capital-intensity levels and high asset values.

Both theory and empirics instruct that we virtually flip the utopian thesis on its head: in economically meaningful settings, intellectual production *does* require intellectual property or some equivalent exclusionary instrument to secure innovation returns and thereby induce innovation investment. Strikingly, this proposition is made most evident in case studies of three markets that *should* be—and are often referenced as—the *most compelling* illustrations for utopian views of intellectual production: pre-modern craft production, academic research and open-source software. Closer analysis shows that these "best cases" are perhaps the most compelling illustrations *against* the utopian thesis: in each market, reputation-driven norms fail to operate as a *stand-alone substitute* for formal or other exclusionary instruments for sustaining innovation investment in economically-significant settings characterized by large numbers, endowment heterogeneity, high capital-intensity levels, and high outside asset values. This insight represents an important analytical step—which, it must be emphasized, does not simply reiterate but substantially re-orients the standard incentive-based view of intellectual property. If we discard utopian aspirations that economically meaningful innovation markets can typically survive without intellectual property or some other imitation barrier, we can usefully reallocate scholarly resources to an alternative promising line of inquiry. Namely: the extent to which sharing regimes, and the supporting norm-based infrastructure, act as an important *complement* that alleviates the transaction-cost burden inherent to formal property rights or other equivalent exclusionary instruments.

To reference this Article's title: sharing practices are ubiquitous in innovation markets but consistently tend to operate in the shadow of, and not in place, of property. This affirmative insight, which represents this Article's central contribution, is vividly illustrated by three case studies of innovation markets, each of which applies at a local level these theoretically and empirically-informed arguments in order to identify and account for mixed-form innovation regimes that integrate sharing practices within a property infrastructure. Remarkably, markets as disparate as premodern craft production, academic research and open-source software exhibit a common "core/perimeter" structure that embeds sharing practices within a property-based infrastructure. This structure consists of (i) a "sharing core" where similarly-endowed innovators exchange knowledge assets subject to certain norm-based constraints, roughly akin to the hypothetical sharing regime, which is then shielded by (ii) a "property perimeter" constituted by legal or extralegal access restrictions, which in turn support a bundled set of excludable products and services in conformity with a conventional property regime. Following this hybrid regime, sharing practices do *not* substitute for intellectual property or other exclusionary equivalents but *do* supply a vital transactional lubricant that facilitates the creation, dissemination and improvement of cultural and technological assets while leaving intact an appropriation platform composed of a tailored combination of property rights and/or extra-legal or technological exclusionary instruments. *Again*, this is a positive, *not* a normative proposition: assuming that the innovator population rationally acts subject to payoff-maximization constraints, it simply *is* the case that certain specified factors will drive firms or individuals to form sharing arrangements in order to eliminate the transaction-cost burdens imposed by a surrounding property regime and realize other mutual gains attendant to pooling knowledge assets. For this purpose, *property is a tonic, not an antidote*: sharing arrangements can "scale up" to "high stakes" (and sometimes *do* scale up to some of the *highest*-stake) environments by using property, contract, technology and other exclusionary instruments to regulate access, thereby precluding the unraveling threats that threaten "stand alone" norm-based sharing regimes.

Organization of this Article is as follows. In Part I, I review utopian claims to the effect that intellectual property or other exclusionary protections are not a typical prerequisite for intellectual production. In Part II, I present an idealized construct of a

sharing regime, which under limited conditions sustains innovation incentives by recourse to social norms in lieu of property rights. In Part III, I assess theoretical expectations as to the limited potency of sharing regimes against a preliminary taxonomy of actual sharing regimes in various innovation settings. In Part IV, I apply these theoretical and empirical insights in detailed case studies of premodern craft production, academic research and open-source software.

## I. The Utopian Impulse

A substantial body of contemporary scholarly and policy discourse, together with casual observations made by the popular press and partisan positions taken by certain user communities and advocacy organizations, contests with varying degrees of intensity the conventional assumption that meaningful property rights or other imitation barriers are a typical precondition for innovation investment.[5] Typical formulations of this line of thinking often look forward to a "world-to-come" where informational goods are disseminated costlessly by intrinsically-motivated individuals assembled into

[5] Any list of references for this line of reasoning will inherently be selective. *See, e.g.,* LAWRENCE LESSIG, FREE CULTURE: HOW BIG MEDIA USES TECHNOLOGY AND THE LAW TO LOCK DOWN CULTURE AND CONTROL CREATIVITY (2004), at 19 (giving examples of non-consented use of original material by scientists, Hollywood studios and Shakespeare), 53-61 (giving examples of film, TV, radio and cable TV industries that were originally founded through various forms of intellectual piracy), and 305-06 (arguing that an intellectual-property regime that requires obtaining consent to use property content stifles novel opportunities for creative expression facilitated by digital and online technologies); LAWRENCE LESSIG, THE FUTURE OF IDEAS: THE FATE OF THE COMMONS IN A CONNECTED WORLD 12-14 (2001) (providing examples of musical creation, scientific research and software development where innovators build on previous contributions and then arguing that "free resources have always been central to innovation" and arguing that free access, rather than a market-based ownership system, is the presumptive regime that should govern informational goods); Madhavi Sunder, *IP*$^3$, 59 STAN. L. REV. 257, 260-61 (2006) (arguing that "rapid-fire technological advances and new forms of creative output, from the advent of open source collaborative networks to . . . the World Wide Web itself, undermine utilitarian intellectual property law's very premise: that intellectual property rights are necessary to incentivize creation"); Michael A. Carrier, *Cabining Intellectual Property Through a Property Paradigm,* 54 DUKE L. J. 1, 36-37 (2004) (questioning the need for copyright given that "many forms of creative expression—fashion, new words and slogans, jokes and magic tricks, and the food industry—have flourished in the absence of protection"). For examples from the advocacy literature, see NANCY KRANICH, INFORMATION COMMONS: A PUBLIC POLICY REPORT (The Free Expression Policy Project, Brennan Center for Justice at NYU School of Law 2004), at 10 (noting that "throughout history" commons regimes have characterized premodern literary production, premodern agricultural production, and management of forests, fisheries and fields, with the suggestion that "therefore" literary and other creative production can proceed vigorously without intellectual-property rights; however, author notes subsequently that "commons research" identifies restrictive conditions under which commons regimes are a sustainable regime for intellectual production); John Perry Barlow, *The Economy of Ideas,* WIRED, Issue 2.03, March 1994 (noting that storytelling, jazz improvisation, stand-up comedy routines and other cultural forms proceed by incremental practices of free circulation and improvement, for which copyright law makes no accommodation, and arguing generally that intellectual property is of doubtful value given that innovators can usually accrue substantial returns as a result of first-mover advantage).

spontaneously-ordered large-number communities or look backwards to a "world-that-once-was" where property rights were mostly absent and intrinsically-motivated innovators freely exchanged valuable knowledge in a collegial pursuit of intellectual and creative expression. These normatively-colored approaches, which sometimes eschew or otherwise relax the analytical constraint that a remunerative mechanism must be identified to support innovation incentives, must be distinguished from strictly positive arguments that identify limited circumstances where self-interested innovators rationally make investments even in the face of substantial imitation, which rewards original contributors by an indirect remunerative mechanism that still presupposes some incomplete level of exclusionary protection.[6] These *non-utopian* assertions (to which I have made previous contributions[7]) raise the possibility that a well-circumscribed class of innovation markets may not require any robust or substantially complete form of, intellectual-property protection, subject to meaningful satisfaction of the identified set of supporting conditions. Properly framed (that is, without making undue generalizations), these arguments simply place incremental limits on the set of circumstances where substantially complete exclusionary coverage is a necessary prerequisite for individually rational investment in innovation activities. This is largely because these arguments do not *really* dispense with meaningful recourse to some form of property rights or other exclusionary instruments, which are usually presupposed to operate in some meaningful capacity in some *other* related market segment, to re-appear at *some other* point in the

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[6] Selected examples include: (i) network externalities whereby producers "give away" samples in order to build an initial platform that increases demand in the long-term, s*ee* Lisa N. Takeyama, *The Welfare Implications of Unauthorized Reproduction of Intellectual Property in the Presence of Demand Network Externalities,* 62 J. IND. ECON. 155 (1994); (ii) indirect appropriability, whereby original producers can price-discriminate so as to appropriate the value attributed by initial consumers to the ability to make subsequent copies, see Stan J. Liebowitz, *Copying and Indirect Appropriability: Photocopying of Journals,* 93 J. POL. ECON. 945 (1985); and (iii) imitators who saturate the low-end market allow high-end producers to credibly commit to higher-valuation "first-period" consumers that they will not subsequently sell to lower-valuation consumers at a lower price, thereby resolving the time-contingency obstacle to supracompetitive pricing, see Lisa N. Takeyama, *The Intertemporal Consequences of Unauthorized Reproduction of Intellectual Property*, 40 J. L. & ECON. 511 (1997). For a broad review of economic explanations for knowledge-sharing behavior in particular, see Julien Pénin, *Open Knowledge Disclosure: An Overview of the Evidence and Economic Motivations*, 21 J. ECON. SURVEYS 326 (2007).

[7] *See* Jonathan M. Barnett, Gilles Grolleau & Sana El Harbi, *The Fashion Lottery: Cooperative Innovation in Stochastic Markets* (Working Paper 2008) [henceforth Barnett et al.]; Barnett, *Shopping for Gucci, supra* note __.

aggregate bundle of products and services, or to be waived for a limited period by entitlement holders until some *later* time.[8]

This important presupposition sometimes implicitly motivates even claims that would otherwise purport explicitly to dismiss, or cast severe doubt on, the necessity for intellectual property or other exclusionary barriers to support innovative output. To illustrate this point, consider a bit more closely now-Justice Stephen Breyer's well-known "uneasy case" for copyright, which *claims* (and is commonly understood) to cast doubt on the economic necessity of copyright protection for books on the ground (among others) that, prior to the extension of U.S. copyright protection for foreign authors in the late nineteenth-century, U.S. publishers entered into contracts to obtain early proofs of English best-sellers and thereby garner a "first-in-time" window in which to capture supracompetitive premia on advance sales (given technological delays in copying by rival publishers).[9] But, properly examined, this argument still implicitly relies on the fact that a combination of legal and technological barriers lurks *somewhere* in the background, providing the original impetus for the creative undertaking in the author's home jurisdiction (and facilitating the underlying contractual agreement), without which the premia obtained by U.S. publishers "even in" the absence of intellectual-property necessarily vanish. Contracts with U.S. publishers on advance copies of an English author's latest novel could not have been written (or, what is certain, would have to have been drastically re-written) if that author had not operated initially under the robust protections of the British copyright regime.

What is really Breyer's uneasy case for *complete* intellectual-property coverage can be generalized across virtually the full range of utopian and semi-utopian claims: upon further inspection, most claims casting doubt on the incentive effects of intellectual

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[8] For completeness, a fourth additional category of arguments should be noted, which propose entirely or substantially replacing intellectual property with an alternative remuneration scheme that dispenses with any exclusivity characteristics. Briefly, these include prizes, grants, and contractual substitutes. Prizes and grants suffer most notably from failure to exploit the pricing mechanism for efficient resource allocation; actually-implemented contractual substitutes are rare and inherently ineffective against third parties. For a general review of prizes, grants and other alternatives to patents, see Nancy Gallini & Suzanne Scotchmer, *Intellectual Property: When Is It the Best Incentive System?*, in INNOVATION POLICY & THE ECONOMY (eds. Adam Jaffe et al., Vol. 2, 2002).

[9] *See* Stephen Breyer, *The Uneasy Case for Copyright*: *A Study of Copyright in Books, Photocopies and Computer Programs,* 84 HARV. L. REV. 281, 299-300 (1970). For a related (and antecedent) argument, see Robert M. Hurt & Robert M. Schuchmann, *The Economic Rationale of Copyright,* 56 AMER. ECON. REV. 421 (1966).

property or practical equivalents are accompanied (or, on closer inspection, are implicitly accompanied) by qualifications that preserve *some* meaningful role for legal or other barriers against imitation. This is even true of some of the most ardent expressions of the utopian view, which often make passing reference to some reduced but meaningful level of property-rights protection "to achieve balance" but then somewhat disingenuously fail to reconcile and integrate this concession with the utopian claims that form the bulk of the remaining argument.[10] This consistent (and, usually either unacknowledged or trivialized) recourse to some exclusionary barrier is indicative of an economic fact concerning innovation regimes in general: even if intellectual production *apparently* proceeds vigorously without legal or other protections against imitation, there *necessarily* must exist some other exclusionary instrument at least to partially "plug" knowledge spillovers and mitigate the resulting disincentive effect. The remainder of this Article is devoted in part to making *explicit* what is almost always *implicit* even in some of the strongest critiques of intellectual property—namely, identifying and describing the staying power of property rights, or some extralegal instrument with at least equivalent exclusionary capacity, in innovation markets that demand economically significant levels of investment. Addressing directly the ubiquitous use of exclusionary protections, whether legal or extralegal, rather than suppressing it as an uncomfortable fact to be shunted aside (and/or reflexively attributing its persistence to powerful rent-seeking interests[11]), allows for construction of an integrated theoretical structure that accounts for *both* the staying power of "property" in innovation markets characterized by widespread imitation and the staying power of "sharing" in markets characterized by robust innovative output. Reasoned dismissal of the utopian approach does not simply reinstate

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[10] Tellingly, other commentators have made similar observations in reviews of Prof. Lessig's book-length works. *See, e.g.*, Julia D. Mahoney, *Lawrence Lessig's Dystopian Vision,* 90 VA. L. REV. 2305, 2324 (2004) (Review of Lawrence Lessig, *Free Culture*) (noting that Lessig states that he is committed to "balance" in intellectual property but observing that he takes the view that peer-to-peer cooperative technologies should flatly trump intellectual-property protections); Sonia Katyal, *Ending the Revolution*, 80 TEX. L. REV. 1465, 1471-72 (2002) (Review of Lawrence Lessig, *Future of Ideas*) (noting that Lessig states that he maintains strong belief in private ownership but observing that this qualification is "slightly disingenuous" insofar as it is not reconciled with the general argument that copyright is unnecessary to support creativity).

[11] The rent-seeking explanation suffers from its own vulnerabilities—in particular, as I argue in a companion publication, it falsely presumes that powerful economic interests universally favor strong intellectual-property rights. The converse is often the case. *See* Jonathan M. Barnett, *Property as Process: How Innovation Markets Select Innovation Regimes* (Working Paper 2008) [henceforth Barnett, *Property as Process*].

an unqualified view that intellectual production can *only* proceed vigorously in the presence of robust exclusionary barrier: surprisingly, the *same* theoretical argument that establishes the inherent weakness of "stand alone" sharing regimes anticipates that an "embedded core" of sharing practices will persist and even thrive within the secure perimeter established by property rights or some other exclusionary equivalent.

## II. Sharing in Theory

In this Part I use a conventional rational-choice framework[12] to anticipate broadly the conditions under which innovation incentives could be plausibly sustained in an environment largely bereft of intellectual property or other equivalent exclusionary barriers. To do so, I construct a hypothetical "sharing regime"[13] that makes no recourse to formal property rights but sustains innovation incentives through social norms that encourage original contributions and discourage excessive imitation. This norm-based mechanism is neither unique nor comprehensive: that is, it is neither the only model that could be conceivably (or has been) formulated to sustain innovation without exclusionary barriers consistent with rational-choice constraints nor a model that encompasses all

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[12] By adopting a rational-choice perspective, I do not mean to deny that altruistic or intrinsic motivations play any role in driving innovation investments, although this is immaterial where the firm, rather than an individual, is the operative decisionmaker, which is the almost-universal case in technology markets and in high-capital-intensity segments of cultural markets. Moreover, by "artificially" removing this factor from the analysis, we can assess how much "work" non-instrumentalist motivations would have to do to sustain innovative output in economically significant settings. A more complex model of innovator behavior would incorporate both instrumentalist and non-instrumentalist motivations in the limited class of innovation markets where that is likely to make a practical difference.

[13] Alternative and approximately overlapping terms used in the relevant literature are "semicommons", a term recently gaining currency in the intellectual property literature, or "common property regime", "limited-access commons" or "managed commons", more-established term with a well-known valence in the political-science and economics literature on common-pool resource governance. Both terms denote fields of activity where there is open access to the relevant asset subject to (i) in the case of a "semicommons" (as contrasted with a "commons"), constraints imposed by property law or other bodies of law, and (ii) in the case of a "common property regime" (as contrasted with an "open-access" commons), constraints imposed by community norms or other informal understandings. By contrast, a "sharing regime" as used in this Article encompasses both terms insofar as it is intended to denote "open" innovation environments that operate subject to constraints imposed by technology or norms and, in the case of a mixed or "closed" sharing regime, by contract and intellectual-property law. For prior and contemporary applications of the semicommons and related concepts in the intellectual-property context, see Michael J. Madison, Brett M. Frischmann & Katherine J. Strandburg, *Constructing Commons in the Cultural Environment* (Working Paper 2008); James Grimmelmann, *The Virtues of Moderation: Online Communities as Semicommons* (Working Paper 2007); Brett M. Frischman & Mark A. Lemley, *Spillovers,* 107 COLUM. L. REV. 257 (2007); Brett M. Frischmann, *Evaluating the Demsetzian Trend in Copyright Law,* 3 REV. L. & ECON. __ (2006); Henry E. Smith, *Governing the Tele-Semicommons,* 25 YALE J. REG. 289 (2005); Robert A. Heverly, *Information Semicommons*, 18 BERK. TECH. L. J. 1127 (2003).

relevant environmental variables; however, it may be viewed as a reasonable "barebones" heuristic to assess at a general but still meaningful level the conditions under which innovation investment can be feasibly maintained without legal or other imitation barriers. Following the economics literature on informal governance of common-pool resources[14] and the law-and-economics literature on "law and norms" [15], the proposed regime replaces formal law that coercively deters imitation with informal norms that achieve an approximately equivalent outcome through a reputation-supported enforcement technology, thereby yielding robust innovative output without the transaction costs and other social losses associated with state-provided property rights. Consistent with these approaches, I recognize that under certain circumstances social norms can plausibly achieve socially-beneficial outcomes roughly equivalent to those that are normally achieved through legal sanctions. However I emphasize the limited range of circumstances under which intellectual-property norms *may* replicate the regulatory outcome that would *certainly* be achieved by robustly-enforced intellectual-property laws. Specifically: a norm-governed innovation regime is a *locally* effective (albeit, low-cost) apparatus under a *narrowly*-defined set of conditions and hence, offers a feasible but substantially imperfect substitute for its legal equivalent, which is a *universally* effective (albeit, high-cost) apparatus under a *broadly*-defined set of conditions.

### A. Regime Structures

Innovation can be usefully construed as a cumulative process initiated by a "first-mover" innovator, who contributes the initial major innovation, and then continued by "subsequent" innovators, who contribute incremental innovations that together improve, refine and extend the original contribution.[16] Collectively these contributions (together with contributions in all other contemporaneous sequences in the same innovation

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[14] *See* ELINOR OSTROM, GOVERNING THE COMMONS: THE EVOLUTION OF INSTITUTIONS FOR COLLECTIVE ACTION (1990).

[15] For the seminal source, see ROBERT ELLICKSON, ORDER WITHOUT LAW: HOW NEIGHBORS SETTLE DISPUTES (1991).

[16] On the sequential nature of most innovation processes, see WILLIAM J. BAUMOL, ENTREPRENEURSHIP, MANAGEMENT AND THE STRUCTURE OF PAYOFFS, Ch. 9.2 (1993) [henceforth, BAUMOL 1993]; WILLIAM J. BAUMOL, THE FREE-MARKET INNOVATION MACHINE 33-34 (2002) [henceforth BAUMOL 2002].

market) constitute what I call the "innovation pool".[17] Following the traditional incentives/access tradeoff, an innovation regime that maximizes output over time must meet two contradictory objectives: (1) on the *incentive* side, it must sustain *first-mover* innovators' incentives to make original contributions to the innovation pool, which relies on exclusionary mechanisms that *increase* transaction costs and input costs for subsequent innovators, and (2) on the *access* side, it must sustain *subsequent* innovators'[18] incentives to generate derivative applications by making withdrawals from the innovation pool, which relies on availability mechanisms that *reduce* transaction costs and input costs for subsequent innovators. As summarized in the Figure below, three broad categories of regimes can be instituted to govern contributions to and withdrawals from the innovation pool, each of which achieves a different tradeoff between first-mover and subsequent innovation incentives. These are as follows: (i) a *commons regime*, which imposes no withdrawal limitations and no contribution requirements, (ii) a *property regime*[19], which imposes complete (or substantially complete) withdrawal limitations through legal or technological constraints but does not impose any contribution requirements, and, in the intermediate region between (i) and (ii), (iii) a *sharing regime*, which uses norm-based instruments to impose contribution requirements and substantially incomplete withdrawal limitations on the innovator population. At one extreme, a commons regime eliminates all access restrictions and the attendant cost burden but does not protect any portion of the innovation pool, resulting in overwhelming disincentives for *first-mover innovation*, so that it can be set aside as a feasible solution to

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[17] This concept is inspired by the empirical literature on informal governance of common-resource pools, which describes successful informal governance structures for renewable resource pools that, following the standard "tragedy of the commons", are otherwise subject to individually rational overuse leading to a collective loss in the form of resource depletion. For the leading source, see OSTROM, *supra* note __. These governance structures seek to avoid resource depletion by regulating individual usage over time so as to ensure that the average "withdrawal rate" does not exceed the average "replenishment rate" over time, but without setting overly strict limitations that fail to maximize the pool's economic yield. While the analogy to a renewable resource pool is obviously imperfect given the inexhaustability of an intellectual asset (as opposed to the limited exhaustability of a renewable physical asset), it is applicable to the extent that, absent any limitations on the surplus of withdrawals over contributions from the collective innovation pool, innovators will be unable to accrue reputational (and collateral financial) returns, thereby precipitating the familiar underinnovation result.

[18] The "first mover" and "subsequent innovator" distinction is equivalent to other distinctions in the literature between "pioneers" and "improvers" or "first movers" and "second movers".

[19] Note that a more exact term for "property regime" would be "proprietary regime" as I mean to include any regime that relies on legal *or* extralegal barriers to restrain imitation. However, the "property/commons" dichotomy is well-established in the literature so I avoid multiplying terms.

the underinnovation problem. At the other extreme, a complete property regime contemplates no unprotected portions of the innovation pool, which easily solves the underinnovation problem but does so by imposing the high cost burdens that attend a formal property-rights system, resulting in substantial disincentives for *subsequent* innovation. Between these two polar alternatives lies a wide variety of sharing regimes, each of which protects *some* portion of the innovation pool, thereby enhancing first-mover innovation incentives relative to a commons regime but without fully incurring the cost burdens that can impede subsequent innovation.

**Table I: Regime Comparison**

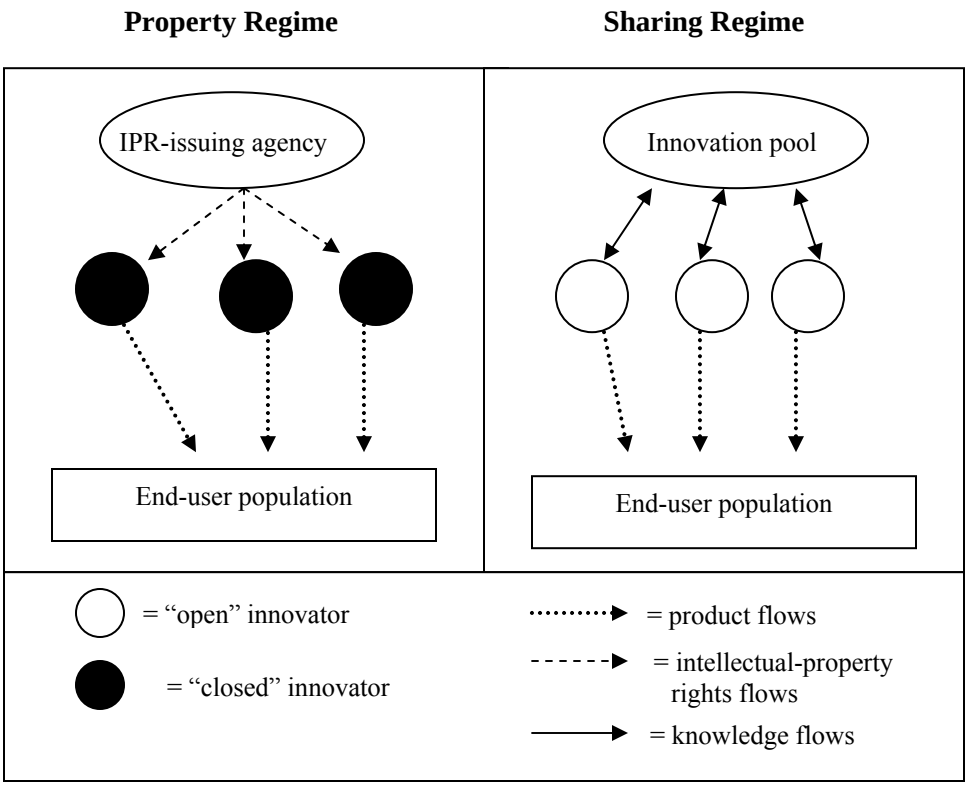
| Regime | Regulatory Instrument | Contribution Requirements | Withdrawal Limitations |
|---|---|---|---|
| **Commons** | None | No | No |
| **Sharing** | Norms | Yes | Yes, but incomplete |
| **Property** | Law | No | Yes |

To induce innovative output without recourse to the effective but costly apparatus of legal entitlements or other exclusionary protections, a sharing regime must implement two social norms, as follows: (i) a *contribution norm*, which mandates that innovators make a certain *minimum* level of original contributions to the innovation pool, which is then freely accessible, and (ii) a *withdrawal norm*, which sets a *maximum* limit to withdrawals made by subsequent innovators from the innovation pool (or, in its weaker form, an *attribution norm* that allows unconstrained withdrawals but requires that subsequent innovators give credit to original contributors). Assuming sufficient compliance among the general innovator population (as further elaborated in the next Section), these contribution and withdrawal norms implement a modified *reciprocity principle* that sustains rational innovation investment even in the absence of legal or technological exclusionary barriers. Each innovator rationally makes original contributions to the common pool on the expectation that (i) given general compliance with the *contribution norm,* it will withdraw from the pool over time roughly the same

value as it contributes to it, and (ii) given general compliance with the *withdrawal norm* (or its weaker version, the *attribution norm*), there will exist some positive imitative distance between original contributions and derivative applications, thereby precluding perfect substitution that would otherwise prevent the former from earning any premium over the latter (in which case the standard underinnovation result would prevail).

Relative to a law-based property regime, a norm-based sharing regime generates a strikingly different transaction structure for the generation, transmission and exchange of innovation assets, as rendered graphically in the Figure below. Under a property regime, unauthorized uses of protected innovation assets are punished at a high cost by legal sanctions enforced through formal dispute-resolution processes funded principally by litigating parties. This formal infrastructure generates a typical exchange pattern consisting of an atomized sequence of high transaction-cost transfers of innovation assets, each of which is held exclusively by each entitlement holder. Under a sharing regime, excessive withdrawals from the innovation pool, and failure to make original contributions to the innovation pool, are punished at low cost through business, reputational and other social sanctions assessed by the market. This informal infrastructure generates a typical exchange pattern consisting of a continuous flow of low transaction-cost transfers of innovation assets, none of which is held on an exclusive basis (in its entirety) by any entitlement holder. Assuming there exists an enforcement technology to elicit contributions to, and restrain withdrawals from, the common innovation pool, a sharing regime constitutes a collectively beneficial arrangement that (i) relative to a commons regime, secures substantial innovation returns for *first-mover* innovators and (ii) relative to a property regime, minimizes the associated transaction costs and input costs borne by *subsequent* innovators. This generic characterization translates into economic terms the strong attraction the utopian thesis exerts over intellectual-property commentary: high appropriation capacities combined with low transaction costs is a socially preferred alternative to the high appropriation capacities combined with high transaction costs of a formal property regime. It now remains to identify the conditions under which this is a socially *feasible* alternative.

## Figure I: Alternative Regimes (Pure-Form)[20]




[20] As used in *Figure I,* "open" innovator refers to an innovator that participates in a nominal-cost exchange of intellectual assets (i.e., a cooperative arrangement); a "closed" innovator does not.

B. Enforcement Technology

The vulnerability of any sharing regime is clear: in the absence of any credible detection and enforcement mechanism, no innovator has any individually rational incentive to comply with the reciprocity norms that support this collectively beneficial outcome, in which case imitations will proliferate in violation of the *withdrawal norm*, which then depresses the premium for original contributions over derivative applications, which then causes innovators to constrain further contributions in violation of the *contribution norm,* in which case the innovation pool will stagnate*,* resulting in failure of the sharing regime and reinstatement of the unique property solution. This critical objection can be usefully elaborated by applying the well-known logic of the "prisoner's dilemma" game to the underinnovation problem. Suppose there are two innovators, each of whom must elect simultaneously between two actions: *cooperate* (i.e., comply with norms, resulting in innovation) or *defect* (i.e., not comply, resulting in imitation); and suppose further that (i) *cooperate* always results in a lower net payoff if the other player elects *defect*, (ii) both players accrue the highest net payoff if both elect *cooperate* (equivalent to *innovate, innovate*), and (iii) both players accrue the lowest net payoff if both elect *defect* (equivalent to *imitate, imitate*). If these innovators are unable to make a credible commitment to each other to elect *cooperate*, then each innovator's individually rational strategy is to elect *defect,* resulting in the collectively undesirable result of universal noncooperation[21], which in turn results in a "waiting game" that yields zero innovation investment. In other words: without the possibility of credible coordination, each player will "tragically" select *defect* (i.e., both wait to imitate)*,* resulting in an individual loss relative to the collectively beneficial outcome where both parties elect *cooperate* (i.e., both do not wait and innovate).

But it is well-known that this dilemma is not without a solution: so long as innovators are repeat-players with sufficiently low discount rates and engaged in an indefinitely repeated sequence of interactions, each may rationally elect *cooperate* in the

[21] This result can be explained in greater detail as follows. Whether or not any innovator believes that the other innovator will "irrationally" elect *cooperate* (i.e., comply with the imitation constraints, in which case electing *defect* necessarily results in a *higher* net payoff) or "rationally" elect *defect* (i.e., *not* comply with the imitation constraints, in which case electing *cooperate* would necessarily result in a *lower* net payoff), it is always the case that electing *defect* results in a higher net payoff than electing *cooperate*. The result: *defect* is the "dominant" strategy and both innovators are locked into a perpetual "waiting game" that yields zero innovative output.

"initial round" so long as it anticipates that discounted future gains in the event of mutual cooperation will exceed one-shot gains from a single defection (and so long as the anticipated losses from "incorrectly" electing *cooperate* in any single round are not too great).[22] Hence, we can reasonably anticipate that, even without the coercive force of the law, a repeat-player innovator will sometimes rationally comply with contribution and withdrawal norms on the belief that doing so will maximize its discounted stream of net expected profits, provided the other innovator acts likewise. But this cooperation strategy has an important limitation. While the anticipated forfeiture of long-term gains as a result of electing *defect* in any individual iteration can generate mutual cooperation in an indefinitely repeated sequence of *two-player* prisoner's dilemma interactions, this does not easily follow in *n-player* settings where no individual election to forego short-term defection gains can be determinative of whether or not a cooperative equilibrium will obtain, which restores the universal noncooperation result.[23]

This problem too is not without a tenable solution: so long as there exists an external instrument that sufficiently adjusts upward and downward, respectively, the relative expected payoffs of *cooperate* (=innovation) and *defect* (=imitation), then self-interested innovators rationally prefer the former action over the latter. Social norms (together with any other supplemental incentive instruments) can play precisely this role by precluding the anticipated breakdown of cooperative behavior in *n*-player settings: reputational rewards and penalties shift relative payoffs and fill the incentive gap that would otherwise result in individually rational—but collectively irrational—defection.[24]

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[22] More fully, this well-known "Tit for Tat" strategy requires that a player elect *cooperate* in the initial round of an iterated sequence and each round thereafter but then revert to *defect* if the other player elects *defect.* Note that this "cooperative" equilibrium (and other variants thereof) has the technical shortcoming that (unlike the mutual defection outcome in a one-shot prisoner's dilemma) it cannot be identified as *the unique* equilibrium; however, it does describe a *possible* equilibrium under certain reasonable assumptions. For a general review of possible equilibrium strategies in the repeated prisoner's dilemma game, see JEAN TIROLE, THE THEORY OF INDUSTRIAL ORGANIZATION (1989), §§ 6.3.1, 6.5.1

[23] There is a technical exception to this statement, which I note for completeness. Even under the assumptions stated above, cooperation may still be individually rational where an individual's marginal contribution independently determines the total amount of the collective good that is provided (the so-called "weakest-link" scenario). This may have practical importance in some contexts. For further discussion, see Elinor Ostrom, *How Types of Goods and Property Rights Jointly Affect Collective Action,* 15 J. THEORETICAL POLITICS 239, 247-48 (2003); CORNES & SANDLER, *supra* note __, at Ch. 2.

[24] For the seminal source on collective-action failure and solutions through supplemental incentives, see MANCUR OLSON, THE LOGIC OF COLLECTIVE ACTION 60-65 (1965). For more extensive and updated discussions of Olson's thesis and the vast theoretical and empirical literature that it has spawned, see Ostrom, *supra* note __; RICHARD CORNES & TODD SANDLER, THEORY OF EXTERNALITIES, PUBLIC GOODS AND CLUB GOODS (1996); TODD SANDLER, COLLECTIVE ACTION (1992).

Together reputational rewards for original contributions and reputational penalties for excessive withdrawals, *plus* any collateral monetary rewards and penalties, drive a repeat-player innovator to conclude that it will maximize anticipated long-term payoffs by electing *cooperate*: meaning, it rationally complies with governing constraints on imitative behavior, and governing requirements to make original contributions, even in the absence of any legal mandate that it do so. In short: the "cooperation payoff" exceeds the "defection payoff" and the sharing regime can stably sustain innovative output.

Based on this simple use of game-theoretic concepts, I can now state more precisely the incentive problem that faces any sharing regime and a tentative solution. A sharing regime bereft of exclusionary protections must encourage sufficient contributions to, and deter excessive withdrawals from, the innovation pool (that is, must deter individually rational incentives to elect *defect*), which in turn yields mutual exchange of knowledge assets over time in conformity with the reciprocity principle, through an enforcement mechanism that detects and sanctions violations, and detects and rewards compliance with, governing norms, thereby sufficiently adjusting the defection payoff and cooperation payoff anticipated by any individual innovator so as to induce rational cooperation. To make this solution "stick", however, it is necessary to address yet another potential difficulty. Namely: even if reputational instruments *could* sufficiently correct any *first*-order incentive problem by adjusting an innovator's cooperation payoff such that it rationally incurs the costs of making original contributions (and avoiding excessive withdrawals) consistent with the norms that sustain a robust innovation pool, this enforcement technology falls prey to a *second*-order incentive problem insofar as it too requires individually irrational expenditures to monitor norm-compliance by market participants and allocate appropriate reputational sanctions and rewards. As a practical matter, this second-order incentive problem may be easily resolved in markets where the reputational infrastructure is administered (i) at relatively little cost, (ii) by the immediate victim of any norm-violation (e.g., failure to attribute) or third-party participants with an independent profit-based incentive to do so, and/or (iii) by collective organizations that spread the costs of norm-enforcement over a wide pool of individual beneficiaries, each of whom must then incur no more than a small contribution cost, thereby mitigating any possible *n*-player prisoner's dilemma. Alas, as the rational-choice skeptic will observe, our problems are not yet at an end: as shall be shown in the next Section, this is neither

the last nor the most pressing obstacle that must be overcome by a sharing regime in order to supply a stable environment for innovation investment in the absence of state coercion.

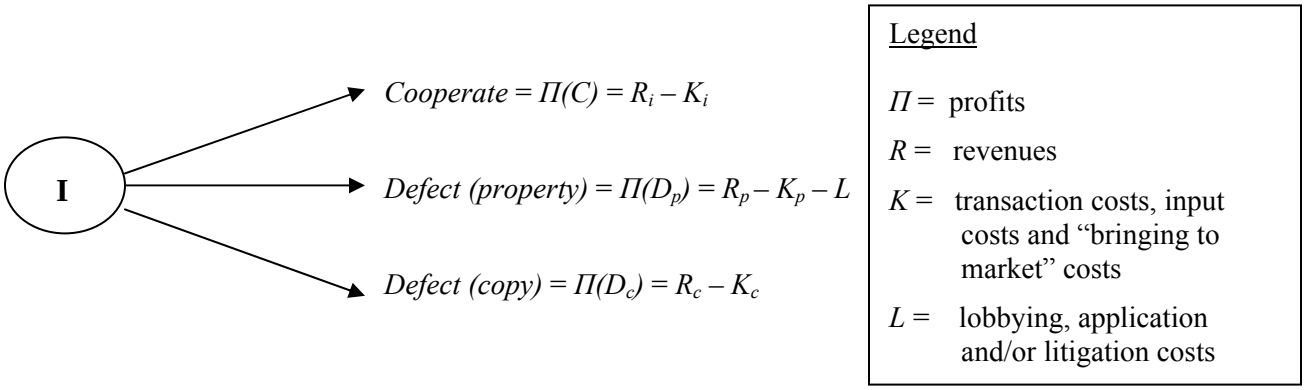
### C. Stability Conditions

So far I have identified the minimal conditions for a sharing regime to persist in any *n*-player setting: (i) innovators must be repeat-players with sufficiently low discount rates, and (ii) there must exist a reputation-based enforcement technology that sufficiently rewards compliance and sufficiently penalizes violations with the governing sharing norms. I will now add a critical third condition, which can cause a sharing regime to fail *even if* the repeat-player and enforcement technology conditions are met. Namely: *there must exist a sufficient level of endowment homogeneity in the innovator population*. This condition rests on a simple rationale: substantial asymmetry in innovation endowments precludes satisfaction of the reciprocity principle that underlies rational forfeiture of knowledge assets to the common innovation pool. Where innovation endowments among participating innovators are not substantially equivalent, then participants with higher-value endowments anticipate that incurring contribution costs will mean "paying into" the pool over time more than will subsequently be "paid out" of the pool. That is: the expected value of total contributions do not approximately match the expected value of total withdrawals, in which case the innovator anticipates a net loss (assuming "side payments" in the form of reputational premia or other supplementary material benefits do not cover the difference) that it then rationally avoids by withholding or limiting its contributions, in which case the standard underinnovation outcome recurs (to which a property regime is the unique solution).

To understand this claim more precisely, let's elaborate (and expand) the "choice set" available to any hypothetical innovator. The innovator's possible actions include: (i) *cooperate,* in the form of making contributions to, and constraining withdrawals from, the pool, (ii) *defect(copy)*, in the form of ceasing contributions to, and making unconstrained withdrawals from, the pool, or (iii) *defect(property),* in the form of lobbying for and enforcing state-provided property entitlements or, more typically, enforcing formally available entitlements that have generally been unused. The Figure

below sets out the corresponding actions and payoffs facing any innovator (denoted below as "I"):

**Figure II: Alternative Actions and Payoffs**[25]




Using this notation, a simple set of conditions for any sharing regime can be stated as follows: it must be the case that $\Pi(C) > \Pi(D_c)$ and $\Pi(C) > \Pi(D_p)$. If either of these inequalities is not satisfied, then any individual innovator will elect either *defect(copy)* or *defect(property*), respectively, as a result of which the sharing regime fails: either (i) underinnovation obtains in the former case as imitations proliferate (i.e., $\Pi(C) < \Pi(D_c)$), resulting in a commons regime that fails to sustain innovative output, or (ii) a state-provided property regime may prevail in the latter case as adoption and enforcement of property entitlements proliferate ($\Pi(C) < \Pi(D_p)$), resulting in a property regime that sustains innovative output at a high transaction-cost burden.[26]

Whether or not any individual innovator is likely to elect *cooperate* over the alternative actions of *defect(copy)* or *defect(property)* is closely dependent on the innovator's "endowment heterogeneity" relative to the general innovator population. All else being equal, any individual innovator is unlikely to elect *cooperate*—that is, is unlikely to believe that $\Pi(C) > \Pi(D_c)$ and $\Pi(C) > \Pi(D_p)$—if it exhibits substantial

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[25] For completeness, I add that an innovator may also elect *defect(withdraw*), in the form of re-allocating investment resources to another use entirely, resulting in a payoff equal to $\pi(w)$, where $\pi(w) = R_w - K_w$. For ease of exposition, this option is not addressed above. Note that the various subscripts, "*i*", "*p*" and "*c*" refer, respectively, to the payoffs corresponding to an innovator's election to *cooperate, defect(property)* and *defect(copy)*.

[26] In a companion paper, I provide a fuller analysis of the interdependencies between innovators' "selections" among property and sharing regimes. *See* Barnett, *Property as Process, supra* note __.

"endowment heterogeneity" relative to the general innovator population. Recall that "innovation endowments" refer to the innovation talent, capacity and assets of any given innovator. Assume that $E_i$ denotes the innovation endowment of any individual innovator, $E_t$ denotes the average innovation endowment of the total innovator population, and $E$ denotes a ratio equal to $E_i/E_t$, so that $E \approx 1$ denotes the average-endowment innovator, $E >> 1$ denotes a high-endowment (or "strong") innovator and $E << 1$ denotes a low-endowment (or "weak") innovator. Endowment heterogeneity (either $E << 1$ or $E >> 1$) necessarily implies higher contribution costs that may not be covered by cooperation gains, which in turn generates two rational deviations from the sharing regime: *defect(copy)* in the case of a weak innovator and *defect(property)* in the case of a strong innovator. Given that a weak innovator inherently incurs higher direct costs to meet contribution requirements, it may anticipate that $\Pi(D_c) > \Pi(C)$, in which case it elects *defect(copy)*. Given that a strong innovator inherently incurs higher indirect costs in light of foregone profits that could be earned under a property regime, it may anticipate that $\Pi(D_p) > \Pi(C)$, in which case it elects *defect(property)*.

Indirectly, both cases may practically reduce to the same outcome. If it is anticipated that (i) imperfect substitutes distributed by weak innovators who elect *defect(copy*) will divert substantial revenues from stronger innovators who elect *cooperate*, which (ii) will then induce even stronger innovators to elect *defect(copy*) to avoid incurring development costs that cannot be recouped in the face of third-party imitation, thereby yielding a commons regime that does not support innovation investment, then stronger firms will rationally elect *defect(property)* to preclude this result and preserve rational incentives to make innovation investments.[27] So long as property rights can be "activated" with some reasonable likelihood at some reasonable cost, then the three-way choice between *cooperate, defect(property) and defect(copy)* reduces as a practical matter to a two-way choice between *cooperate* and *defect(property*).

[27] In a variant of this scenario, a weak innovator may elect *defect(property)* so as to obtain dubious patent rights over critical but unclaimed technologies and then extract nuisance settlements from incumbent innovators. This latter strategy is most effective in innovation markets characterized by high product complexity (so that the holder of a patent covering a small but necessary component of a bundled product can extract a disproportionate hold-up value equal to the alleged infringer's design-around cost).

Somewhat counterintuitively, the entry of relatively strong or weak innovators has the *same* effect: it undermines the stability of even an apparently robust sharing regime as an incentive structure for sustaining innovation investment, thereby directly or indirectly driving some or most innovators to defect from an informal sharing regime "into" a formal property-rights regime (or, to the extent a formal property-rights regime is unavailable, to defect by withdrawing from the market entirely). This outcome derives fundamentally from the fact that cooperation payoffs are not calibrated upward to reflect weak and strong innovators' relatively higher direct or indirect contribution costs, which in turn violates the reciprocity principle that sustains the rational forfeiture of knowledge assets to the common pool: remunerative benefits *paid out* do not reflect contribution costs *paid in*, in which case the sharing regime cannot induce rational cooperation from innovators across the full distribution of innovation endowments. This observation yields two implications. First, it implies that in the intermediate region of the endowment distribution where innovators *do* have substantially similar endowment levels, then contributions will roughly match withdrawals, there is no rational incentive to *defect* and the sharing regime stably persists. Second, it implies that toward the extreme ends of the endowment distribution, there is no rational incentive to elect *cooperate* and the sharing regime at best persists unstably, leaving it susceptible to being unraveled by a sufficient number of defections, either *defect(copy)* on the "low end" of the endowment distribution (which then hypothetically yields a commons regime and, by anticipation, actually yields a property regime) or *defect(property*) on the "high end" of the endowment distribution (which then yields a property regime). These proposed relationships and anticipated outcomes are depicted below.

**Table II: Innovator Types; Payoffs; Outcomes**

| **Innovator Type** | **Payoffs; Actions** | **Regime Outcome** |
|---|---|---|
| Strong ($E >> 1$) | $\Pi(C) < \boldsymbol{\Pi(D_p)} > \Pi(D_c) \rightarrow$ *defect(property)* | Property |
| Average ($E \approx 1$) | $\Pi(D_c) < \boldsymbol{\Pi(C)} > \Pi(D_p) \rightarrow$ *cooperate* | Sharing |
| Weak ($E << 1$) | $\Pi(C) < \boldsymbol{\Pi(D_c)} > \Pi(D_p) \rightarrow$ *defect(copy)* | Property ("by anticipation") |

This Table, and underlying argument, can be reduced to a single phrase: *endowment homogeneity supports regime stability*. Where this condition is satisfied, then most or all innovators will conclude that $\Pi(D_c) < \Pi(C) > \Pi(D_p)$ and the sharing regime is sustained; where it is *not* satisfied, then some or most innovators will conclude either that $\Pi(C) < \Pi(D_c)$ (in the case of a weak innovator) or $\Pi(C) < \Pi(D_p)$ (in the case of a strong innovator). Put simply: it does not "pay" for differentially-endowed innovators to exchange, rather than use property rights to safeguard, valuable knowledge since, absent a side-payment mechanism (whether in the form of reputational, financial or other valuable capital) to correct for disparities in innovation endowments, the interchange of withdrawals and contributions to the collective innovation pool over time will inherently fail to satisfy the reciprocity principle that ensures a net gain from the forfeiture of knowledge assets to the innovation pool. This result can be usefully rephrased in terms of simple externality logic. Where weak innovators engage in widespread imitation, the negative externalities imposed by excessive withdrawals from the innovation pool induce stronger innovators to petition the state to replace the existing sharing regime with a property regime that internalizes those negative externalities. By contrast, the positive externalities generated by substantial contributions to the innovation pool by strong innovators induce the latter to adopt and enforce formal intellectual-property rights in order to internalize those positive externalities. The result in either scenario restores property as the unique solution to the underinnovation outcome: as endowment heterogeneity increases, a sharing regime must give way to more robust exclusionary instruments in order to preserve rational innovation incentives.

This line of reasoning is substantially consistent with a large body of theoretical and empirical research in various collective-action contexts, including public-good experiments in controlled settings[28], empirical studies of common-pool governance

[28] Subject to some exceptions, relevant experiments find that private contributions tend to decrease as endowment homogeneity decreases, and increase as endowment homogeneity increases. *See* Ledyard, *supra* note __, at 158-160. *See, e.g.,* Hackett et al., *The Role of Communication in Resolving Commons Dilemmas: Experimental Evidence with Heterogeneous Appropriators,* 27 J. ENV. ECON. & MGMT. 99 (1994) (finding that in *n*-person commons dilemmas, endowment heterogeneity reduces earnings relative to endowment symmetry and is associated with a reduced ability to agree on allocation rules). For a related result that focuses on payoff asymmetry, see Martin Beckenkamp, *Cooperation in Symmetric and Asymmetric Prisoner's Dilemma* (Working Paper 2007), avail. at www.ssrn.com (showing that asymmetry in payoffs prevents cooperation over long-term in a repeat-play prisoner's dilemma game, because low-type players have strong incentive to defect). This is an incomplete list of relevant experimental studies.

arrangements[29], and, most consistently, theoretical and empirical research on cartel stability[30], all of which tend to find to find an inverse relationship between contribution rates and endowment heterogeneity (usually understood more broadly in this context to include all resources available to fund participant contributions).[31] These bodies of research observe additional factors that can plausibly have an important influence on individually rational incentives to make contributions to, and limit withdrawals from, the innovation pool in conformity with the norm-based constraints of a sharing regime. Some of the leading factors of greatest relevance can be described (in unavoidably summary fashion and at the cost of some simplification[32]) as follows, each of which increases the payoff from electing *defect(property)* relative to the payoff from electing *cooperate* under a sharing regime. First, an increase in the size of the innovator population challenges a norm-based enforcement technology by increasing monitoring costs, thereby reducing the ability to punish defection with reputational sanctions and credit cooperation with reputational rewards, which effectively causes the defection payoff under a property regime to exceed more easily the cooperation payoff under a sharing regime. Second, in capital-intensive innovation markets that necessitate development and other "bringing to market" costs that are large relative to imitation costs borne by third parties, it is almost certainly the case that the possible losses in the event a

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29 *See* Eggertson, in ANDERSON & MCCHESNEY, *supra* note __. For further discussion (which describes some limited diversity of results), see Ostrom, *supra* note __, at 257-58.

30 This literature shows that cartel stability is highest where membership exhibits cost and product homogeneity and declining otherwise, absent the ability to make corrective side payments (usually difficult to implement given antitrust constraints). *See* SCHMALANSEE & WILLIG, *supra* note __, at 417-30.

31 I note that the theoretical public-goods literature observes that the effect of heterogeneity (and group size, to the extent that heterogeneity is a positive function of group size) on private provision of public goods can be ambiguous. Specifically: under certain conditions, endowment heterogeneity can *increase* contribution rates where there is an increased probability that there exist extreme types who have sufficient interest and resources to unilaterally contribute to the public good independently of whether or not other contributors are doing so. *See* Pamela E. Oliver & Gerald Marwell, *The Paradox of Group Size in Collective Action: A Theory of the Critical Mass,* 53 AM. SOC. REV. 1 (1988), Ostrom, *supra* note __, at 257-58, and, citing relevant contributions, CORNES & SANDLER, *supra* note __, at __. Note that this argument assumes that contributors cannot take actions to exclude non-contributing third parties from enjoying the relevant public good (i.e., cannot "convert" the public good into a private good). By contrast, the analysis above envisions that innovators *can* do so at some positive likelihood and some non-exorbitant cost by "activating" state-provided property entitlements (i.e., by electing "*defect(property)*" using the terminology introduced above), in which case substantial endowment heterogeneity can never be conducive to a high-endowment firm's incentives to *contribute without making recourse to property rights*.

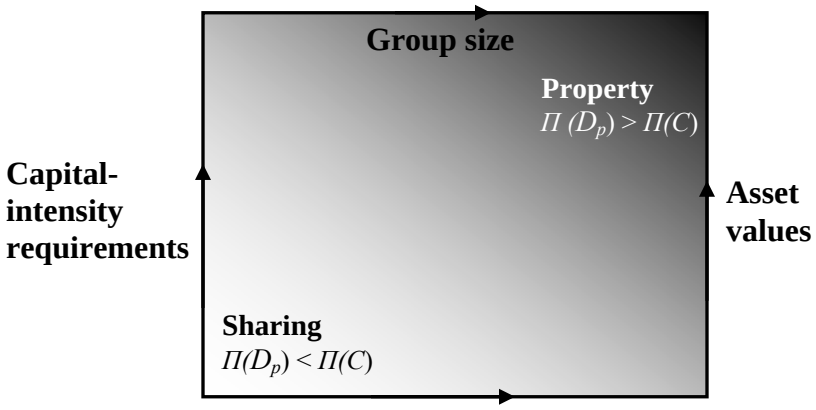
32 A contemporary contribution proposes an approach, originating in the work of Elinor Ostrom and colleagues on informal governance of common-pool resource regimes, that identifies a large set of factors that may influence the formation and maintenance of "commons regimes" in cultural environments. *See* Madison et al., *supra* note __.

competitor elects *defect(copy)* are so great that, absent the secure legal protections of a property regime or practical equivalent, no innovator will rationally incur the development costs required to fund the relevant innovation project. Third, strong innovators are likely to have enhanced incentives to defect into a property regime where the economic value of the relevant asset category is unusually high, in which case it becomes improbable that electing *cooperate* will yield an expected payoff, together with any reputational side-payments, that can cover the opportunity cost of forfeiting knowledge assets to the innovation pool.

Taken together with the principal discussion above, these factors suggest that, generally speaking, the stability of any norm-based sharing regime will decline as any of the following variables increases: (i) endowment heterogeneity in the innovator population (the focus of the foregoing analysis), (ii) the number of innovators, (iii) capital-intensity requirements and (iv) the economic value of the relevant asset. The proposed impact of these parameters on the stability of a sharing regime—that is, on the likelihood that any innovator population elects "sharing" (i.e., *cooperate*) over "property" (i.e., *defect(property)*)—are summarized in the box diagram shown below.[33]

[33] For ease of exposition and for the purpose of illustrating general tendencies, this diagram assumes linear relationships between these variables; however, there is no inherent reason to believe this would be the case in any particular instance. That is: endowment heterogeneity may have a much stronger effect than number of innovators on cooperation payoffs relative to defection payoffs, or *vice versa*, in which case the "box" would be replaced by a figure drawn with substantially different proportions. Following the prior Figures, increasing coloration denotes increasing use of practices indicative of a property regime, and vice versa.

**Figure III: Regime Determinants**[34]




The box diagram yields the following hypothesis: the most highly developed sharing practices should exist in markets characterized by low capital investment, low economic values, and a concentrated group of relatively few and substantially similar firms (denoted by the "southwest" region where $\Pi(D_p) < \Pi(C)$); conversely, the least developed sharing practices should exist in markets characterized by high capital investment, high economic values and a dispersed group of multiple heterogeneous firms (denoted by the "northeast" region where $\Pi(D_p) > \Pi(C)$). But observe the "wide open" middle of the diagram[35]: this designates a broad intermediate region where the market will clearly *not* support undiluted property and sharing regimes, which implies in turn both that (i) a "pure" sharing regime bereft of exclusionary protections is a rare occurrence outside of economically insignificant markets that meet certain parameter conditions but (ii) a "pure" property regime bereft of sharing practices is a rare occurrence outside of economically intensive markets that meet certain parameter conditions. This in turn carries a key implication that I will now pursue as I move from hypothetical to actual sharing regimes: as a general tendency, I expect to find that

[34] Following prior usage, increasingly dark coloration indicates greater use of practices indicative of a property regime; conversely, increasingly light coloration indicates greater use of practices indicative of a sharing regime.

[35] Note that the "northwest" and "southeast" corners of the box yield ambiguous stability expectations: in the former case, group size and endowment heterogeneity are low, favoring cooperative, but asset values and capital-intensity requirements are high, favoring property; in the latter case, group size and endowment heterogeneity are high, favoring property, but asset values and capital-intensity requirements are low, favoring cooperative.

innovation markets will typically operate subject to a mixed-form sharing regime where low-cost knowledge-exchange practices operate together with some meaningful state-provided exclusionary protections or practically equivalent instruments in order to secure innovation returns while minimizing the associated transaction-cost burdens on innovation investment.

Part III. Sharing in Action

A theory is only as good as its ability to account for the facts it sets out to explain. The hypothetical sharing regime has *not* been proposed to *definitively* identify a universally valid set of conditions under which rational investment in innovation activities can be sustained without robust exclusionary barriers.[36] Hence, the *hypothetical* sharing regime is only a *useful* construct if it provides a tool by which to anticipate and account for *actual* conditions under which innovation is likely (and *not* likely) in typical circumstances to proceed without robust barriers against third-party imitation. In this Part I review available information on actual sharing regimes or reasonably close variants thereof[37], which yields a systematic (if still preliminary) taxonomy of appropriation mechanisms in innovation markets that thrive without reliance on intellectual-property protections.[38] The resulting landscape of sharing regimes and related arrangements exhibits two general tendencies that largely conform to the core theoretical expectations set forth above. First, the hypothetical model of a norm-based sharing regime, which places heavy reliance on reputational rewards and sanctions, is substantially implemented in markets that support innovative output with little reliance on formal intellectual-property rights or other barriers to imitation. Second, these substantially pure-form sharing regimes tend to be confined to markets where innovators place little investment capital at risk and, even in these settings, usually make some

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[36] That would be a grossly overambitious task given the inherent complexity of public-goods and collective-action problems, to which, as any review of the literature attests, see Ostrom, *supra* note __, there is undoubtedly more than one solution depending on a variety of case-specific variables (only some of which have been covered in the extended discussion above).

[37] For purposes of this exercise, a sharing regime is understood to mean any innovation market (or market segment) where a substantial portion of the relevant pool of innovation assets is unprotected by intellectual-property protections or other access limitations, whether as a formal or effective matter.

[38] For another attempt at organizing the landscape of knowledge-sharing arrangements, see Julien Penin, *Open Knowledge Disclosure: An Overview of the Evidence and Economic Motivations*, 21 J. ECON. SURVEYS 326 (2007).

meaningful recourse to intellectual property or other exclusionary instruments. Beyond these small-scale environments, the anticipated result is realized: the enforcement technology behind a norm-based sharing regime can no longer easily support innovation incentives and makes increasing use of state-provided property entitlements and/or extralegal exclusionary instruments in order to shield innovation returns against imitators.

But there is a third observation of vital importance: the emergence of a formal property regime does not typically *displace* knowledge-sharing arrangements from innovation markets. Construed in generic terms as any nominal-cost mechanism for knowledge exchange among market participants, *sharing practices* recur across a broad range of innovation settings that are otherwise subject to formal property-rights protections, even at higher capital-intensity settings involving large numbers of differentially-endowed participants. Following utopian inclinations, this fact *could* be interpreted to advance the proposition that intellectual production sometimes does not require exclusionary barriers to third-party access. Properly construed, however, this final observation substantially embellishes the standard incentive-based understanding of intellectual property and nicely integrates into a long-term payoff-maximization framework: even under a formal property-rights regime, repeat-player innovators seek to preserve nominal-cost mechanisms for knowledge exchange that preserve the low transaction-cost structure of a sharing regime. Remarkably, the contractual design of these "embedded" sharing arrangements is driven by—and far more easily implements—the *same* reciprocity principle that drives the norm-based design of stand-alone sharing regimes that operate without recourse to formal property rights. Through the use of property and contract to regulate access, these finely-tuned sharing arrangements can "scale" at even the most economically intensive settings by regulating group size and composition so as to ensure satisfaction of the reciprocity principle and thereby preclude individually rational defections that would threaten stand-alone sharing regimes that have no recourse to state-provided property entitlements. In short: sharing is most stable with property, not without it.

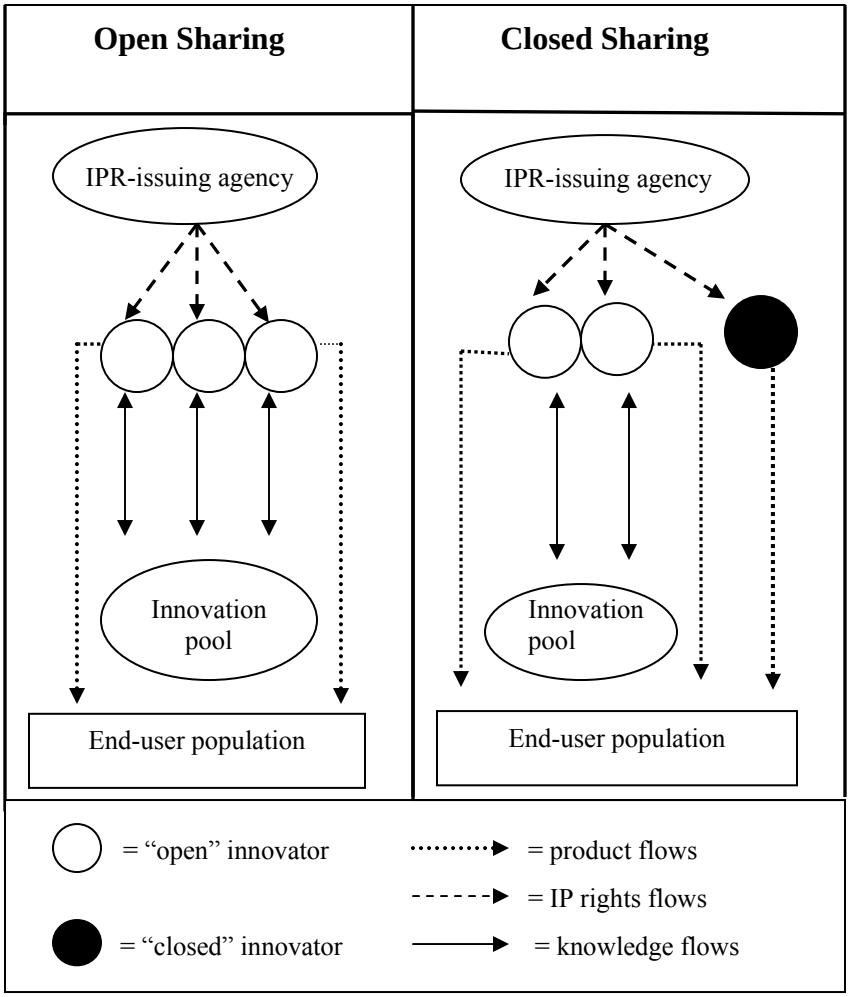
### A. Regime Taxonomy

Even innovation markets that operate subject to a sharing regime—meaning, markets where a substantial portion of the underlying pool of innovation assets is

unprotected by legal entitlements—rarely operate in the complete absence of any intellectual-property protections. Hence, actual sharing communities are best situated along an "access continuum" ranging from (i) "open" versions where intellectual-property rights are formally available but weak, regularly waived or otherwise largely unused, as a result of which at least some innovation assets are deposited in a collective pool to which all participants have access; to (ii) "closed" or "semi-closed" versions that make substantial recourse to formal intellectual-property rights but maintain innovation pools that are accessible to member firms subject to a mix of contractual and informal obligations.[39] The Figure below provides a graphical illustration of these two "mixed-form" sharing regimes (*open/closed cooperation*), each of which may be compared with the two "pure-form" regime alternatives (*sharing/property*) illustrated above in *Figure I*.

[39] For somewhat similar distinctions between informally-organized and formally-organized knowledge-sharing mechanisms, see Penin, *supra* note __. More generally, these distinctions correspond approximately to the distinction between "inclusive" and "exclusive" clubs (i.e., voluntary associations that provide local public goods to club members) in the collective-action literature. For further discussion, see SANDLER, *supra* note __, at Ch. 2.

**Figure IV: Alternative Regimes (Mixed-Form)**[40]




[40] Note that, following previous usage, "open" innovator refers to an innovator that participates in a nominal to low-cost exchange of intellectual assets; a "closed" innovator does not.

This abstract distinction between closed and open sharing regimes translates as a practical matter into a graduated continuum of sharing regimes with different levels of non-negotiated third-party access, as set forth in the Figure below. Moving from right to left, access costs to the existing knowledge stock increase as the innovator population makes increasing recourse to the state property-rights system and decreasing recourse to the reputational reward and sanction mechanisms that support a norm-governed sharing regime. Approximately as the Figure moves from low-capital-intensity markets in the research, design, professional and cultural fields to high-capital-intensity markets in the technology and manufacturing fields, market participants make greater use of state-provided property rights generally, greater use in particular of the strongest forms of intellectual property-rights protections (moving from trademark and trade dress to copyright to patents), and lesser use of reputational norms for supporting innovation incentives. The economic logic seems clear. As the innovator population places greater capital at risk as a result of technological requirements (meaning: it anticipates higher expected in the event it incorrect elects *cooperate* and a competitor elects *defect(copy)*), it rationally moves from a norm-governed innovation regime, which can secure innovation returns at low capital intensities by recourse to reputational rewards and sanctions, to a law-governed regime, which can secure innovation returns even at high capital intensities by recourse to the coercive power of the state: i.e., increased losses in the event of expropriation justify the increased transaction-cost burdens imposed by the strongest form of legal protection, relative to weaker informal and formal protections.[41] Hence, utopian observations that certain low-capital-intensity environments (on the "right side" of the spectrum) sustain innovative output without recourse (or without substantial recourse) to intellectual-property protections presumptively (but not certainly) fail to generalize (to the "left side" of the spectrum) to higher-capital-intensity environments, which are unlikely to induce rational investment by self-interested innovators in the absence of a secure barrier against third-party expropriation.

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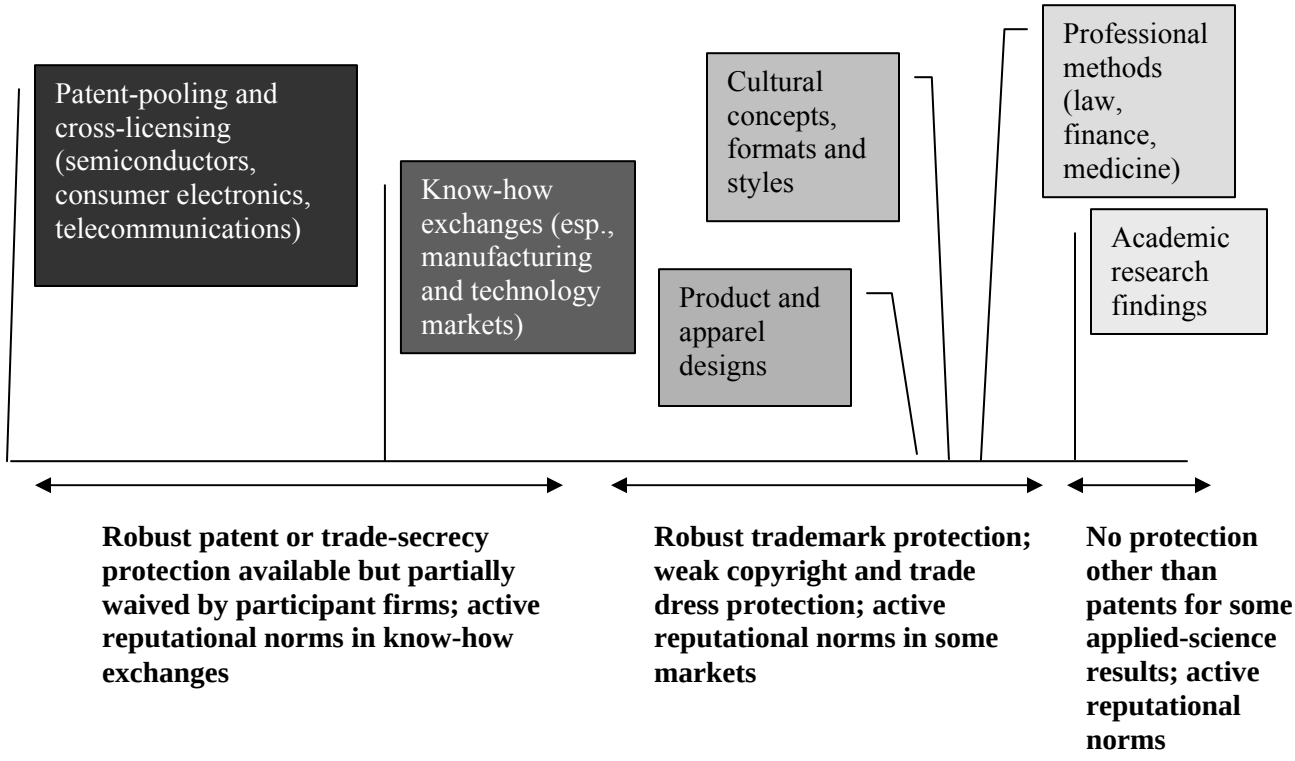
[41] Scientific research (which does require substantial capital investment) is the exception to this relationship, which in turn accounts for the extensive subsidies provided to this market. For further discussion of this last point, see *infra* Part IV.B. Note that the observed relationship does not imply that a norm-governed innovation regime could not operate at higher capital intensities assuming other relevant environmental variables were hospitable to it—e.g., a small-number homogenous community where rational incentives to elect *cooperate* are otherwise robust—but it tilts the odds against this possibility considerably.

**Figure V: Sharing Regime Continuum**[42]




B. *Open Communities.*

Open sharing communities persist in forms substantially untouched by any formal property-rights protections with respect to an important set of product attributes and are therefore the best possible contemporary candidates to support some meaningful scope of application for the utopian thesis. The most economically salient markets that fall within this category can be classified into four broad categories: (i) *research* – i.e., scientific and other academic research, where abstract ideas are ineligible for patent protection; (ii) *design* – fashion and (to a somewhat lesser extent) product design, where design patents, copyrights and trade dress generally offer unreliable protection for utilitarian components of any garment or industrial design[43]; (iii) *culture* -- plots, routines, formats and certain

[42] For simplicity, this chart ignores the limited availability of patent protection for financial-method innovations, which has existed since 1998. Following earlier usage, increasingly dark coloration corresponds to increasing propertization, and *vice versa*.

[43] More specifically: (i) design patent protection is usually practically ineffective given the associated delays and costs, (ii) in light of *Wal-Mart Stores, Inc. v. Samara Bros., Inc.*, 529 U.S. 205 (2000), trade dress protection requires showing "secondary meaning" (except possibly in the case of

other conceptual elements used in film, television and theatrical productions, where there is weak protection against non-literal style and format imitation (or an express exemption under the *scenes à faire* doctrine); and (iv) *professions* – methods or procedures used in law, finance and the medical professions. Legal protections against substantial imitation in these markets are generally absent, weak or ineffective, and, as a result, there is widespread and regular circulation of concepts, methodologies and/or designs, which are then modified and re-circulated without any remuneration flowing directly to the original contributor. Consistent with the theoretical model, it should be expected that reputational rewards and sanctions would be deployed to cover the incentive shortfall generated by incomplete intellectual-property coverage, which in turn ensures a rough parity of net contributions to the collective innovation pool over time and a premium for original contributions over derivative applications, thereby precluding the underinnovation result.[44] As described in greater detail subsequently with respect to academic research[45], these open sharing communities approximately implement the norm-based regulatory structure of the hypothetical sharing regime: formal and informal mechanisms for allocating inventive credit assure that original contributors accrue substantial reputational rewards while, in certain higher-end market segments, slavish imitators incur reputational penalties (or, to the extent trademark protections apply, legal penalties) for excessively close replications of successful originals.

This general structure approximately tracks the imitation norms documented in the growing body of empirical studies of cultural and other market segments covered by weak or minimal intellectual-property protections, which include to date: luxury furniture design, luxury French restaurants, "extreme-sports" equipment hobbyists, magicians,

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product packaging, following *Two Pesos, Inc. v. Taco Cabana*, 505 U.S. 763 (1992)), and (iii) copyright protection is unavailable to any utilitarian articles (and generally, any "conceptually inseparable" component thereof).

[44] Note that this is a general explanation; specific markets may require consideration of other factors to account for innovative vigor under low intellectual-property protections. For example, I and co-authors argue elsewhere that firms tolerate constrained levels of imitation in the fashion market in order to mitigate the risk of failing to recoup development and marketing costs under conditions of extreme demand uncertainty, in which case reputational pressures may play a subsidiary role in sustaining innovation incentives (or may be symptomatic of a more fundamental incentive structure). *See* Barnett, *Fashion Lottery, supra* note __.

[45] *See infra* Part IV.B

stand-up comics and online "fan fiction" contributors.[46] Consistent with theoretical expectations, each of these innovation communities are relatively small in number, demand low capital investment, appear to have relatively homogenous innovation endowments and maintain informal mechanisms for administering reputational rewards and penalties that regulate compliance with market norms that in turn govern contributions to, and withdrawals from, the innovation pool. To illustrate a bit further, consider one well-documented example: the luxury furniture industry in Belgium and the Netherlands, where there is little effective protection against design imitation other than unreliable copyright protections, but high-end designers nonetheless generally abide by social norms that limit excessive imitation and reward original contributions in the form of reputational credit (which is then sometimes monetized in the form of increased sale premia awarded to creative designers), which is in turn facilitated by frequent informal and formal communications among competing designers that can stigmatize any firm that violates market convention.[47] As this market illustrates, extensive investments in social reward and sanctioning mechanisms substitute in part for state provision of complete intellectual-property protections for the purpose of inducing innovation investments that are otherwise subject to third-party replication.

Following utopian inclinations, any of these markets (and the supporting reputational apparatus) could be generalized as a paradigm case for the proposition that intellectual production does not require any robust form of intellectual property in some meaningful set of cases. But an important characteristic common to all these markets immediately counsels against any such interpretation. Namely: *none* of these markets constitute "pure" stand-alone sharing regimes—that is, there is always some positive

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[46] *See* Dotan Oliar & Christopher Sprigman, *Intellectual Property Norms in Stand-Up Comedy*, __ Va. L. Rev. __ (2008) (stand-up comedy routines); Emmanuelle Fauchart & Eric von Hippel, *Norm-Based Intellectual Property Systems: The Case of French Chefs,* 19 ORG. SCI. 187 (2008) (luxury French restaurants); Greg Lastowka, *Digital Attribution: Copyright and the Right to Credit,* 87 B.U. L. REV. 41 (2007) (digital forms of literary creation); Jacob Loshin, *Secrets Revealed: How Magicians Protect Intellectual Property Without Law* (working paper 2007) (magic tricks), avail. at www.ssrn.com; Rebecca Tushnet, *Payment in Credit: Copyright Law and Subcultural Creativity,* 70 L. & CONTEMP. PROBS. 135 (2007) (online fan fiction); Sonali K. Shah, *From Innovation to Firm Formation in the Windsurfing, Skateboarding and Snowboarding Industries* (Working Paper 2006) (U.S. amateur extreme-sports hobbyists and small-business owners); Gerda Gemser & Nachoem Wijnberg, *Effects of Reputational Sanctions on the Competitive Imitation of Design Innovations,* 22 ORG. STUD. 563 (2001) (Dutch and Belgian luxury furniture design).

[47] *See* Gemser & Wijnberg, *supra* note __.

level of intellectual-property protection available: (i) in *research* markets, copyright protection against literal replication of verbal content, patent protection for some applied-science findings, (ii) in *design* markets, trademark protection against unauthorized reproductions of name and logo (and, in non-apparel design markets, patents or trade secrets over other components of the relevant product); (iii) in *culture* markets, trademark protection over name and logo and copyright protection against literal reproduction of written, visual or musical expression; and (iv) in *professional* markets, trademark protection over name and logo (and, in finance, recently enacted but still-controversial patent protection for certain financial methods).[48] Moreover, even where intellectual-property protections are especially minimal or ineffective, there often exists a great deal of tacit knowledge (e.g., research findings), technological opacity (e.g., magic tricks or cuisine) or associated products, services or other business capacities (e.g., financial methods that are packaged together with the difficult-to-imitate reputational capital of a premier financial institution) that frustrates easy or perfect imitation by third-party competitors of the total product or services bundle provided by the original contributor. This fact is critical because some threshold level of exclusionary protection, whether provided legally or extralegally, means that some product attributes are *not* thrown into the collective innovation pool, thereby precluding exact replication and allowing consumers to distinguish between originators and imitators, which in turn enables the reliable operation of the attribution technology that supports the accurate allocation of reputational awards and sanctions, which in turn generates the collateral streams of monetary returns for original contributions, which in turn supports rational innovation investment . . . entirely consistent with the conventional incentive model! So, at best, these markets are really paradigm cases for the important proposition that intellectual production sometimes or even often does not require *a lot* of intellectual property (or some practical equivalent).

In close conformity with theoretical expectations, this global survey of open sharing communities yields a highly qualified proposition that sets strict bounds to any practical realization of the utopian thesis. Namely: *intellectual production at low capital*

[48] It is possible to patent medical procedures; however, this is now practically moot in light of a 1996 amendment to the Patent Code that immunizes physicians and medical facilities from liability for infringement of any medical procedure patent.

*intensities among small-number populations with substantially homogenous innovation endowments usually does not require strong levels of intellectual property, which is largely (but not completely) replaced by social norms that impose imperfect constraints on unauthorized imitation*. This narrow proposition implies in turn that this norm-based incentive structure is unlikely to generalize to economically-significant innovation environments, which, subject to other identified factors, therefore *do* require robust forms of exclusionary protection. Subject to further case-specific inquiry, social norms are *un*likely to substitute adequately for intellectual property or other exclusionary protections in "large-scale" innovation markets characterized by high capital-intensity investments, high numbers, high endowment heterogeneity and high economic values for the relevant asset class. But this does not consign sharing mechanisms to the exotic margins of contemporary markets for technological and cultural production, although it does alter the lens through which we may be accustomed to view sharing mechanisms in cultural or technology markets. This proposition has an important *positive* implication that reserves an important place for sharing practices *even* in large-number and capital-intensive environments, where sharing practices are unlikely to operate as a *substitute* for intellectual property, but *are* likely to operate as an important *complementary* mechanism for reducing the transaction-cost burden that inherently accompanies extensively-implemented property-rights protections.[49] Just as property has staying power even in innovation markets characterized by low levels of capital investment, so too sharing practices have staying power even in innovation markets characterized by high levels of capital investment.

### C. *Closed Communities*

Closed sharing communities operate in innovation markets that widely adopt available formal intellectual-property protections, decline to enforce these rights with respect to recurring knowledge exchanges with certain (usually, substantially similar peer) competitors, but *do* enforce these rights to restrain access by other (usually,

[49] Sharing arrangements and other forms of interfirm cooperation can play other important purposes in innovation markets, including most notably, achieving gains from collective cost-cooperative and risk-cooperative mechanisms. For an exploration of the former possibility, see BAUMOL 2002, *supra* note __, at Ch. 6-7; for an exploration of the latter, see Barnett et al., *supra* note __.

substantially *dis*similar non-peer) competitors. These arrangements effectively construct an innovation pool to which only member firms have access, subject to any contractual agreement as to contribution requirements, withdrawal limitations and collateral royalty or other payments. These closed sharing arrangements appear in two forms, broadly defined. First, there exist multiple local districts and other geographic industrial clusters in crafts, industrial design, high-technology and some manufacturing industries where competing firms engage in regular informal exchanges of technological know-how (or equivalently, know-how embodied in fluid human capital that regularly shifts between employers[50]), thereby effectively waiving trade-secrecy protections in a segment of a larger industry that, in most cases, otherwise *does* make regular recourse to intellectual-property protections.[51] Second, a wide variety of manufacturing and high-technology industries employ, or have employed, extensive cross-licensing, patent-pooling and other sharing arrangements grounded in a partial effective waiver of certain intellectual-property protections.[52] Today a large portion of the consumer electronics industry operates on the basis of arrangements that pool "essential patents" contributed by

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[50] The interfirm exchange of human capital appears to characterize Silicon Valley in particular. *See* ANNE SAXENIAN, REGIONAL ADVANTAGE: CULTURE AND COMPETITION IN SILICON VALLEY AND ROUTE 128 (1994) (high-technology industry in Silicon Valley and Boston area); Ronald Gilson, *The Legal Infrastructure of High Technology Industrial Districts: Silicon Valley, Route 128 and Covenants Not to Compete,* 74 N.Y.U. L. REV. 575 (1999).

[51] *See, e.g.*, Eric von Hippel, *Cooperation between rivals: informal know-how trading,* RES. POLICY 1987 (minimills in steel industry); Stephan Schrader, *Informal technology trading between firms: Cooperation through information trading,* 20 RES. POLICY 153 (1991) (same); Michael R. Glass & David J. Hayward, *Innovation and Interdependencies in the New Zealand Custom Boat-Building Industry,* 25 INTL J. URBAN & REGIONAL RES. (2001) (New Zealand custom boat-building industry); R.C. Allen, *Collective Invention*, 4 J. ECON. BEHAV. & ORG. 1 (1983) (blast furnace industry in 19th-century Cleveland, England); A. Nuvolari, *Collective Invention During the British Industrial Revolution: The Case of the Cornish Pumping Engine,* 28 CAMBRIDGE J. ECON. (2004) (steam-engine industry in Cornwall, England mining district). This is a substantially incomplete list of know-how exchange and similar arrangements. For a discussion of some additional examples, see BAUMOL 2002, at 86-90.

[52] Prof. Robert Merges has supplied the pioneering research in this area. *See* Robert P. Merges, *Contracting into Liability Rules: Intellectual Property Rights and Collective Rights Organizations,* 84 CALIF. L. REV. 1293, 1340-1354 (1996); Robert P. Merges, *Institutions for Intellectual Property Transactions: The Case of Patent Pools,* in DREYFUSS & ZIMMERMAN, *supra* note __ [henceforth Merges, *Patent Pools*]. I am excluding from this discussion performance rights organizations that pool copyrights relating to musical compositions (e.g., BMI and ASCAP), the reason being that these organizations simply pool intellectual property entitlements primarily in order to economize on licensing and enforcement costs and not for the purpose of facilitating knowledge-sharing among competing producers. Some, but not all, patent-pooling entities may share this characteristic.

participating firms in connection with a variety of industry standards.[53] Perhaps even more extensively, the semiconductor industry rests on a complex network of cross-licensing arrangements, where large firms typically enter into broad "field-of-use" agreements that provide parties with reciprocal access to an agreed-upon pool of patented assets, and industry-level research consortia, where large firms cooperate in research, development and related activities, thereby creating a common innovation pool accessible to all dues-paying members.[54]

A closed sharing community that makes recourse to formal property rights to exclude non-members is substantially more stable than an open sharing community that does not make use of any such exclusionary mechanism and, as a consequence, can support innovation investments at substantially higher capital intensities in technology-intensive industries. Simply put: contract plus property rights backed up by the threat of state coercion (to which no entities are immune) provide a far more powerful and sophisticated technology for maintaining regime stability than the faulty and primitive technology supplied by social norms and the threat of reputational sanctions (to which some entities are rationally immune). Consistent with the incentive structure described previously, the impressive extension of closed sharing communities across a wide variety of innovation markets follows logically from the fact that (i) stability is enhanced in sharing communities characterized by a limited number of major players each having similarly sized innovation endowments, (ii) property rights enable participating firms to preserve stability by implementing access limitations and ongoing contractual requirements that regulate community size and endowment heterogeneity, and (iii) contractual rights foreclose or limit defection opportunities into the surrounding property regime, specifically through grant-back provisions that require all members to contribute

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[53] For detailed discussion of some of these arrangements, see U.S. PATENT & TRADEMARK OFFICE, PATENT POOLS: A SOLUTION TO THE PROBLEM OF ACCESS IN BIOTECHNOLOGY PATENTS? (Dec. 5, 2000), at Appendix, avail. at http://www.uspto.gov/web/offices/pac/dapp/opla/patentpool.pdf; information available on the "MPEG LA" website, see http://www.mpegla.com. For overviews of patent-pooling arrangements, see Anne Layne-Farrar & Josh Lerner, *To Join or Not to Join: Examining Patent Pool Participation and Rent-Cooperative Rules* (working paper 2007), avail. at www.ssrn.com; TEECE, *supra* note __, at App. A.1.1; David Serafino, *Survey of Patent Pools Demonstrates Variety of Purposes and Management Structures,* KNOWLEDGE ECOLOGY INTERNATIONAL, RESEARCH NOTE 2007:6 (2007).

[54] For a detailed description of cross-licensing, research consortia and other sharing arrangements in the semiconductor industry, see Barnett, *Property as Process, supra* note __.

all "essential" patents relating to the relevant technology standard. Any cross-licensing or patent-pooling arrangement must regulate community composition in order to preserve regime stability, for which purpose two principal instruments are employed: (i) access limitations that effectively reduce endowment heterogeneity by requiring certain minimal technological contributions to the collective pool (often accomplished through a certification mechanism that assures compliance with the technological standard), and (ii) contractual requirements that "correct for" endowment heterogeneity through compensatory cash payments to cover any lack of parity or calibrated royalty payments that reflect substantially higher or lower-value contributions to the collective pool.

Both of these internal regulatory mechanisms enable firms to satisfy the reciprocity principle (either in practice or as reconstructed artificially through side payments) that otherwise would dissuade rational participation by firms that could accrue higher gains by acting independently under the surrounding property regime (equivalent to electing *defect(property)*). The outcome: a limited-number of participating firms with substantial endowment homogeneity and, consequently, a high level of regime stability. Evidence on participation patterns in patent-pooling, cross-licensing and know-how exchanges is consistent with this expectation: (i) a firm is more likely to enter into a patent pool when its "patent quality" is similar to that of the patent pool's standard technology, (ii) firms with especially valuable technological assets often opt out of participating in a patent pool (especially if a value-sensitive royalty formula is lacking but even when it is present in some cases)[55] and (iii) in industries where even direct competitors routinely exchange proprietary know-how, firms are more likely to do so with firms who have high-value technology resources and, notably, often "defect" from the sharing norm by using property rights to safeguard the most high-value knowledge assets.[56] The collective gains from sustaining the low transaction-cost structure of a

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[55] *See* Farrar & Lerner, *supra* note __. The authors cite the example of Lucent, who chose not to participate in the MPEG-2 patent pool, unlike most other major players in the industry, apparently on the view that it could extract greater value by licensing its especially valuable patents independently. (It turned out to be mistaken and, based on the "MPEG LA" website, is now a member.) *See* http://www.mpegla.com.

[56] On patent pools, see note [53]. On references to studies of know-how exchanges, s*ee supra* note [51].

sharing regime are especially substantial in complex or multi-component technologies such as software, semiconductor or consumer electronics, where any product consists of hundreds of patentable components and almost inevitably gives rise to a reasonable infringement claim, which in turn implies that full-fledged deployment of available property rights could drown innovation in a morass of legal motions, court proceedings and so forth.[57]

It may be argued that this thesis does not fully characterize some multi-firm cross-licensing, standard-setting and patent pooling arrangements, which sometimes cover a broad range of market participants with heterogeneous endowment levels. But this discrepancy actually reflects the stability of the hybrid governance structure that characterizes a closed sharing community, which overcomes two vulnerabilities in an open sharing community that has no recourse to state-provided property rights. First, on the "high end" of the endowment distribution, these sharing communities are able to generate a calibrated cooperation payoff that induces some strong-innovator participation through tailored royalty-stream allocations and other payment mechanisms that reflect the most resource-rich members' disproportionate contribution (sometimes complemented by allowances that permit high-endowment participants to exclude the most valuable patent assets).[58] Second, on the "low end", these sharing communities are able to induce some participation by weak innovators due to the exclusionary mechanisms that at least partially eliminate any anticipated defection payoff (that is, increase the cost of remaining outside the resource pool to which community members can restrict access[59]) while contractual devices may be able to accommodate low-endowment innovators without unduly eroding the cooperation payoff of the existing pool of high-endowment

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[57] Moreover, formal property rights allow prospective members to safely and credibly disclose to each other endowment levels with a reduced risk of third-party expropriation, which may be a necessary precondition to entering into a closed cooperative community that rationally seeks to limit membership heterogeneity.

[58] *See* Merges, *Patent Pools, supra* note __.

[59] On the cost of remaining outside a "technology-sharing" consortium, see BAUMOL 2002, *supra* note __, at Ch. 6-7; BAUMOL 1993, *supra* note __, at Ch. 10. Baumol makes the important point that, in contrast to ejection from a price-setting cartel (where the ejected member can continue to profit from the supracompetitive prices set by the cartel), ejection from a technology-sharing consortium results in no benefits except to the extent there are information spillovers. This contingency obviously improves the cooperation payoff in the latter scenario.

innovators. This is a somewhat paradoxical result: selective use of state-provided property rights (together with use of state-provided contract law) allows the sharing community to capture the "dangerous" low and high fringes of the innovator population, which, while *increasing* endowment heterogeneity within the sharing community, decreases the defection payoff for low-endowment innovators and increases the cooperation payoff for high-endowment innovators, thereby protecting the cooperation payoff for average-endowment innovators against weak innovators who elect *defect(copy)* and strong innovators who elect *defect(property)*, which in turn can threaten the stability of a sharing arrangement.

## IV. Sharing/Property Symbiosis

In this Part, I provide detailed case studies of sharing arrangements in three disparate markets—premodern craft guilds, academic research and open-source software—that are often referenced as, or would presumptively appear to be, paradigm illustrations for the utopian thesis that intellectual production does not require imitation barriers. Substantially consistent with both (i) theoretical expectations based on the hypothetical construct of a sharing regime, as presented in Part II, and (ii) the global tendencies in actual sharing regimes, as presented in Part III, these closely-examined markets show the common or intuitive understanding to be almost entirely false. Innovation investments in these weakly propertized markets critically rely on, and would be unlikely to persist without, collateral exclusionary instruments that generate remunerative streams to support innovation incentives. By explicitly dispensing with any utopian interpretation that these markets successfully sustain (or sustained) innovative output unencumbered by exclusionary protections, it is then possible to observe a consistent pattern in the mixed implementation of property components (meaning, exclusionary instruments) and sharing components (meaning, knowledge-exchange arrangements) that constitute the hybrid innovation regime that governs (or governed) these markets. By lifting the analytical cloud imposed by utopian approaches that assume that "free appropriation" is the presumptive regime choice, it is possible to identify the remarkable manner in which otherwise historically and technologically disparate markets consistently mix property and sharing components to secure innovation returns while

minimizing the associated transaction-cost burden. As shown in detail below, all three markets exhibit a mixed-form regime structure where (i) a "sharing core" persists at the heart of a substantially propertized environment, which in turn supplies an important palliative to the heavy transaction-cost burden of the "property perimeter" established by state-provided legal entitlements, while (ii) the "property perimeter" sustains the sharing core by enabling innovators to calibrate contribution payoffs so as to induce rational forfeitures of knowledge assets to the innovation pool. To appreciate the analytical ground that has been covered, the reader is encouraged to compare these actually-implemented innovation regimes (each of which is presented graphically in *Figures VI, VII* and *VIII* in the following discussion) with the idealized "pure-form" and generic "mixed-form" innovation regimes presented previously in *Figures I* and *IV* respectively.

A. Craft Guilds

For an observer intent on identifying substantial realizations of sharing regimes as anticipated by the utopian thesis, history is a good place to start: various forms of sharing regimes appear to have been the *standard* (or at least, a widely used) governance structure for innovation markets, as illustrated vividly by the guilds and similar organizations that widely characterized Western European crafts industries for approximately five centuries through as late as the end of the eighteenth-century in some jurisdictions and markets.[60] At the cost of overgeneralization, the basic guild structure was as follows: the organization was usually assigned an exclusive (or semi-exclusive) license to provide a certain product in a certain territory and was further empowered to enforce its rules and regulations on its members, which generally prescribed detailed rules concerning, among other things, the employment and training of apprentices and conformity of working processes and finished products with guild standards. Not only

[60] Crafts guilds (associations of artisans) and merchant guilds (associations of traders) were leading forms of economic organization in medieval and early-modern Europe. The historical literature is vast and can only be referenced selectively. For useful overviews, see PAMELA O. LONG, OPENNESS, SECRECY, AUTHORSHIP 72-101 (2001); S. R. Epstein, *Craft Guilds, Apprenticeship and Technological Change in Preindustrial Europe,* 58 J. ECON. HIST. 684, 689-90, 706-07 (1998); Sylvia Thrupp, *The Gilds,* in THE CAMBRIDGE ECONOMIC HISTORY OF EUROPE 231 (ed. M. M. Postan et al., Vol. III 1963). For an important prior contribution addressing the importance of guilds to modern intellectual-property scholarship, see Robert P. Merges, *From Medieval Guilds to Open Source Software: Informal Norms, Appropriability Institutions and Innovation,* Working Paper (2004) [henceforth Merges, *Guilds*].

were guilds sometimes the preeminent venues for economic production in premodern Western Europe but guilds are commonly cited as a paradigm example of a norm-driven community that successfully sustains widespread compliance through accumulations of social capital by its members.[61] In place of legally enforceable entitlements held by individual innovators, guilds avoided underinnovation outcomes through substantial compliance with community norms to the extent maintained by business and other social sanctions among guild members (often tied together by neighborhood, religious and kin relationships[62]) and between guilds, and as complemented further by collateral benefits in the form of collective branding, knowledge-sharing, collective representation, risk-spreading, financial credit, and cost-sharing mechanisms.[63] Following the basic construct of a sharing regime, each guild adhered (or claimed to adhere) to community norms that promoted mutual disclosure of technical knowledge (including as embodied in the common pool of apprentice labor)[64], thereby yielding a collective pool from which members could make withdrawals and to which members could make contributions (in each case subject to guild regulations and associated social norms that sometimes limited permitted contributions), thereby reducing the transaction costs of knowledge exchanges and the input costs of knowledge generation among individual craftsmen.[65] English guilds advertised precisely this informal knowledge-sharing mechanism in arguing against the liberal application of patent protection for certain mechanical inventions in the late 17th and early 18th centuries.[66]

Utopian approaches sometimes make reference to premodern forms of intellectual production as "proof" for the thesis that original contributions can be sustained in the

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61 *See* Sheilagh Oglivie, *Guilds, Efficiency and Social Capital*: *Evidence from German Proto-Industry,* 57 ECON. HIST. REV. 286 (2004).

62 *See* Epstein, *supra* note __, at 701.

63 On these collateral benefits, see *id.*, at 686-88. For further discussion, see Ulrich Pfister, *Craft Guilds and Proto-Industrialization in Europe, 16th to 18th Centuries,* in GUILDS, *supra* note __.

64 *See* CHRISTINE MACLEOD, INVENTING THE INDUSTRIAL REVOLUTION: THE ENGLISH PATENT SYSTEM, 1660-1800 (1988), at 83. *See also* Thrupp, *supra* note __, at 274 (noting that cost-reducing process innovations would be shared among members of the guild and kept secret from outsiders).

65 Robert Merges views guilds as a form of "collective invention" whereby members used secrecy practices and other mechanisms to appropriate returns from innovation activities. *See* Merges, *Guilds, supra* note __.

66 *See* MACLEOD, *supra* note __, at 188. MacLeod emphasizes that the ideal of mutual cooperative of technical improvements was not always realized in practice.

absence of expected monetary or other remuneration.[67] This simply assumes that no functionally-equivalent exclusionary mechanisms were employed by cultural and technology markets prior to the advent of formal intellectual property, a proposition that (to this author's knowledge) has received little inquiry and, at least with respect to the craft guild, would be seriously misleading. The craft guild *never* operated as a "stand-alone" incentive structure as contemplated by the idealized construct of a norm-governed sharing regime; rather, *every* guild operated under the protection of a state-granted exclusive license (or one of a restricted set of licenses), or functional equivalent, that protected the relevant guild against imitation by non-members, as complemented by secrecy procedures and statutory authorizations to enforce guild rules through exclusion and other sanctions. As shown in the Figure below, a guild is best viewed as a voluntarily-formed sharing arrangement (denoted by the box with bolded lines) embedded within a formal property regime constituted by exclusionary entitlements allocated by the state, which in turn generated revenue streams that sustained innovation incentives by the guild as a whole. While it is true that there were few intellectual-property protections at the *individual* level (although, quite importantly, not none, as we shall soon see), these protections were robust at the *group* level. Through this modified property-rights regime, the guild entity avoided the transaction costs of a fully deployed intellectual-property regime but, through grant of an exclusive or semi-exclusive license, sustained innovation incentives by permitting guild members to internalize as a collective entity some of the social gains generated by private investment.[68]

To be sure, as a practical matter, historians observes that the monopoly license was highly imperfect (especially in markets with high economic values, which widely attracted outside entry), which accounts for the fact that some guilds regularly experienced lapses in market coverage[69], or, to preempt such a result, lobbied for

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67 *See supra* note [5].

68 Obviously grant of a monopoly license may to a certain extent *depress* innovation investments given the absence of any potential entry threat, which is the conventional view of guild organizations. The evidence appears to suggest that this reputation is partly undeserved and that resistance to innovation generally increased as a function of market power (and conversely, decreased otherwise), *see* Epstein, *supra* note __, at 694-96, and Thrupp, *supra* note __, at 271-79. For a defense of the conventional view, see Oglivie, *supra* note __.

69 *See* Thrupp, *supra* note __, at 276-78; Epstein, *supra* note __, at 705-06.

intellectual-property protections that could be asserted by guild members against non-members, or made limited use of the quasi-patent rights that were available on a limited basis in France, Great Britain and other leading jurisdictions in the early modern period.[70] But, even where the state-granted license securely blocked entry by non-guild competitors, it still did not address an inherent defect that threatened the guild with underinnovation failure (a fate to which some or even most guilds may have fallen prey, or actively pursued, given the guilds' general reputation for technical conservatism[71]). While the guild license sustained collective incentives to make innovation investments, it did not provide any support for individual incentives to make innovation investments—meaning practically, either innovation investments in new process technologies or transferring technical knowledge to apprentices—without some further remunerative mechanism. A partial remedy for this defect may have been provided by the technical requirements for guild membership, which effectively screened out weak innovators and, in turn, assisted in preserving some approximate parity between contributions and withdrawals from the collective innovation pool. But this effective protection against knowledge spillovers to weak innovators still did not provide a rational incentive for a strong innovator to incur the costs of generating innovations (and transmitting innovations to apprentice labor) that would then be thrown into the collective pool with no direct remuneration for the contributing innovator. Guilds used a variety of devices to address this vulnerability, including: (i) permitting highly innovative members to extract some return on private innovations by implicitly allowing the use of secret cost-reducing technical processes provided the final product conformed to the guild standard[72], (ii) quasi-bartering schemes whereby innovative artisans exchanged secret technical improvements[73], (iii) inviting non-members in possession of technical innovation to join

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70 On the use of patent rights by craft guilds, see Epstein, *supra* note __, at 703-04. For a detailed history of early forms of patent rights in pre-industrial England, see MACLEOD, *supra* note __.

71 *See* Epstein, *supra* note __, at 693 (noting and partially contesting this impression); MACLEOD, *supra* note __, at 113 (same, with respect to English guilds in particular).

72 This point is emphasized in Epstein, *supra* note __, at 693-95. For further discussion with respect to 15th-century Venetian glass-making guilds, see LONG, *supra* note __, at 91-92 and Merges, *Guilds, supra* note __, who observe that guilds sometimes allowed members to keep technical processes secret.

73 *See* MACLEOD, *supra* note __, at 188.

the guild (often in exchange for not opposing issuance of a patent)[74], or, in other cases, (iv) providing individuals with special remuneration or prizes for major innovations that would then be available to guild members generally.[75]

These various internal regulatory mechanisms functioned to preserve the reciprocity principle that falters in any sharing community as endowment heterogeneity increases: strong innovators will rationally constrain participation in the sharing regime in the absence of calibrated reward mechanisms that reflect differentially-valued contributions to the common innovation pool. Consistent with our theoretical expectations, erosion of the reciprocity principle posed a key threat to the longevity of any guild organization: unless substantial parity between contributions and withdrawals among differently-endowed innovators could be assured, either by regulating entry into the guild and/or allocating compensatory side-payments to high-endowment innovators, the latter group would rationally constrain contributions or, given suitable historical circumstances, defect into a state-provided property regime where appropriate remuneration for original contributions could be assured. Several historical incidents illustrate this risk. The 18th-century Lyon silk-weaver guilds sometimes experienced intense disputes between the guild (or certain relevant state entities) and especially talented craftsmen over appropriate additional remuneration for a major process innovation, which sometimes prompted the disputant to appeal to state authorities for a patent over the disputed innovation[76] (equivalent to electing *defect(property)* following our earlier analysis). More generally, historians observe that highly innovative guild members were sometimes "bought out" (that is, induced to defect) by rival jurisdictions or guilds in exchange for a one-time royalty payment (functionally equivalent to a lump-sum payment for an intellectual-property right), a not uncommon occurrence as higher-value supraregional markets developed with correspondingly increased economic rewards

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74 *See id.*, at 83-84.

75 For examples of these policies in the 18th-century Lyon silk-weaving industry, see Dominique Foray & Liliane Hilaire Perez, *The economics of open technology: collective organization and individual claims in the "fabrique lyonnaise" during the old regime,* in NEW FRONTIERS IN THE ECONOMICS OF INNOVATION AND NEW TECHNOLOGY (ed. Cristiano Antonelli et al. 2006).

76 *See* Foray & Perez, *supra* note __.

for technological advances.[77] Not coincidentally, the rapid growth of these larger and more lucrative markets in the early 19th-century, and the resulting increased ability of talented (in our terms, high-endowment) artisans to withdraw innovation assets from the collective innovation pool constituted by craft guilds, seems to have played some part in the ultimate decline of the guild organization and the concomitantly increased usage of the formal patent system.[78] Consistent with our general thesis, as outside economic values and endowment heterogeneity increased, the most talented innovators rationally withheld contributions to the collective pool, the innovation pool declined in value, and the guild inevitably unraveled.

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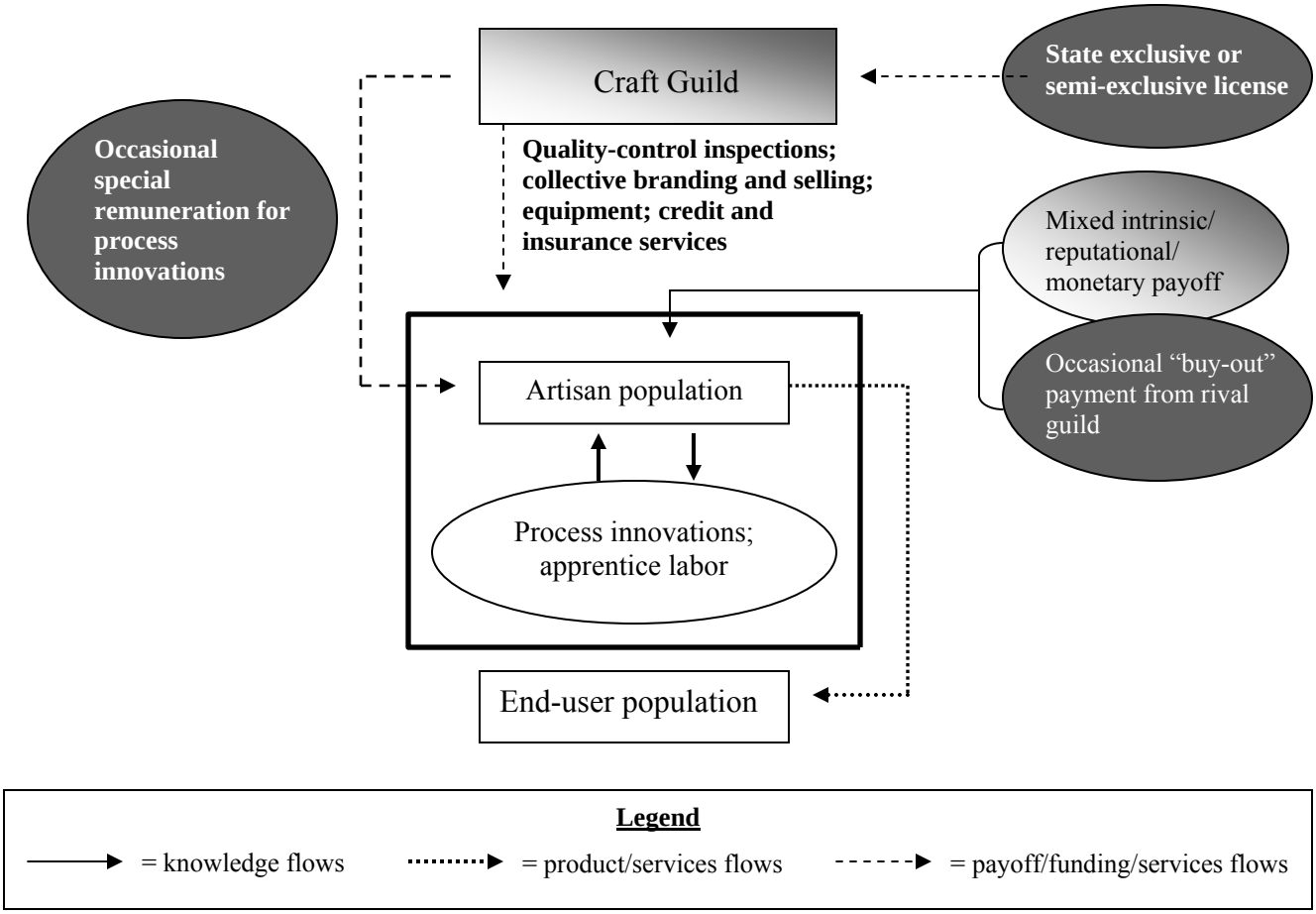
77 *See* Epstein, *supra* note __, at 703-05; MACLEOD, *supra* note __, at 147.

78 *See* Epstein, *supra* note __, at 705-07. Other commentators argue that the capital accumulation in a mature industry enabled individual merchant-manufacturers to undertake production of certain goods without recourse to the cost-cooperative and risk-spreading advantages of the guild mechanism. *See* Ulrich Pfister, *Craft Guilds and Proto-Industrialization in Europe, 16th to 18th Centuries,* in GUILDS, ECONOMY AND SOCIETY (ed. Clara Eugenia Nunez 1998).

**Figure VI: Mixed-Form Sharing Regime in Craft Guilds**[79]




[79] Consistent with prior usage, darker coloration denotes practices indicative of a property regime; lighter coloration denotes practices indicative of a sharing regime; intermediate coloration denotes mixed practices indicative of both regimes.

B. Academic Research

Historically, basic research results have generally not been subject to formal property-rights protection (aside from patent protection for some applied results in the hard sciences) and in virtually all academic fields the free exchange of research findings is a widely encouraged practice (and the hoarding of research results is a widely *dis*couraged practice) that results in rapid dissemination of knowledge assets. These norms generate what is effectively a shared innovation pool from which researchers at competing institutions make withdrawals subject to attribution to the contributing author and to which researchers make contributions in the form of preliminary and published research findings. Setting aside for a moment the limited availability (and even more limited *use*) of patent protection in some fields of scientific research, what propels rational investments of time and effort by researchers in intellectual production where the positive externalities generated as a result cannot even be partially internalized? The answer, as sociologists of science have observed, conforms precisely with the hypothetical construct of a norm-driven sharing regime. Social practices operate in virtually all disciplines to award reputational rewards that sustain output in academic research, where researchers follow first-order openness norms that mandate uncompensated forfeiture of private knowledge in exchange for the prospect of reputational prestige for innovation success, which is in turn supported by a second-order normative obligation to give credit to prior innovators (and sanction harshly those who fail to give credit).[80] Reputationally-driven contribution norms in the academic research market rest on a transparent and low-cost attribution technology—namely, the citation—that facilitates the fine allocation of credit among contributing researchers based on citation counts, peer-review processes and journal placement, subject to adjustment based

[80] See ROBERT MERTON, THE SOCIOLOGY OF SCIENCE 286-324 (1968); JEROME R. RAVETZ, SCIENTIFIC KNOWLEDGE AND ITS SOCIAL PROBLEMS 41-42, 245-259 (1971). For further and more recent discussion, see Christopher Kelty, *Free Science,* in PERSPECTIVES ON FREE AND OPEN-SOURCE SOFTWARE, *supra* note __, at 416-427; Paul A. David, *Patronage, Reputation and Common Agency Contracting in the Scientific Revolution,* Stanford Institute for Economic Policy Research, Discussion Paper No. 03-39 (Aug. 2004), avail. at www.ssrn.com [henceforth, David, *Patronage*]; Partha Dasgupta & Paul David, *Toward a New Economics of Science,* 23 POLICY RES. 487 (1994); Paula E. Stephan, *The Economics of Science,* 34 J. ECON. LIT. 1199 (1996). The role of informal reputation-based norms in academic research is mentioned in the canonical work on norm-based substitutes for legal regulation, see ROBERT C. ELLICKSON, ORDER WITHOUT LAW: HOW NEIGHBORS SETTLE DISPUTES 59-64, 258-64 (1991).

on discipline-specific norms.[81] Reputational capital has two further benefits. First, it is a naturally compounding asset, meaning that substantial accruals of reputational capital (as measured by the citation metric, academic prizes and more qualitative measures) may enable a researcher to pay the functional fee required to gain access into the most elite professional circles that regularly engage in formal or informal discussions of the most advanced methodologies or findings in the relevant field.[82] Second, researchers can partially monetize reputational capital in certain disciplines—as measured quantitatively by reference to citation counts and qualitatively by subjective impressions of the originality of any particular contribution—into higher salaries, outside publishing contracts, consulting engagements and other material benefits.[83]

Consistent with an open sharing model that relies heavily on reputational carrots and sticks to overcome any potential threat of excessive withdrawals from the common innovation pool, regular use of this attribution technology in conformity with the governing norm is supported by potentially severe reputational sanctions: perfect imitation without attribution (i.e., plagiarism) can result in career-ending reputational (or other institutional) penalties while failure to make contributions results in the self-explanatory "publish or perish" outcome. This norm-based compensation regime does not appear to be subject to any second-order enforcement dilemma as might be anticipated theoretically, especially in a large-number environment involving tens of thousands of competing researchers. The attribution norm appears to be so deeply internalized as part of the "scientific ethic" that heated priority disputes are often undertaken most vigorously not by the relevant contributors but by unrelated observers in

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81 On attribution and reputational norms in scientific and other academic scholarship, see Catherine Fisk, *Credit Where It's Due: The Law and Norms of Attribution*, 95 GEORGETOWN L. J. 49, 64-65, 81-85 (2006); Arti K. Rai, *Regulating Scientific Research: Intellectual Property Rights and the Norms of Science,* 94 NW. U. L. REV. 77, 88-94 (1999); Robert P. Merges, *Property Rights Theory and the Commons: The Case of Scientific Research,* in SCIENTIFIC INNOVATION, PHILOSOPHY AND PUBLIC POLICY 148-52 (eds. Ellen Frankel Paul et al. 1996) [henceforth Merges, *Scientific Research*]; Rebecca S. Eisenberg, *Property Rights and the Norms of Science in Biotechnology Research,* 97 YALE L. J. 177, 181-84 (1987).

82 *See* Paul A. David, *Communication Norms and the Collective Cognitive Performance of "Invisible Colleges",* in CREATION AND TRANSFER OF KNOWLEDGE: INSTITUTIONS AND INCENTIVES (ed. Navaretti et al. 1998), at 128-29.

83 *See* Stephan, *supra* note __. Another contributor has calculated the incremental economic value of academic publications and citations in certain disciplines. *See* Arthur Diamond, *What is a Citation Worth?*, 21 J. HUMAN RESOURCES 200 (1998).

the relevant literature.[84] Consistent with the sharing model, original researchers who widely disclose valuable knowledge can accrue substantial reputational rewards, allocated both through professional prestige, continuously operating mechanisms for peer review, and a wide variety of formal honors (up to 3,000 scientific awards are reportedly available in North America[85]), with the ultimate example being eponymy (e.g., Parkinson's Disease).[86] Through this combination of market norms, and a well-developed enforcement apparatus of peer-review journals, grant-making institutions and other entities that make appropriate allocations of reputational capital to outstanding researchers, the academic research market provides the most vivid contemporary example of an innovation pool sustained largely without recourse to state-provided property rights.

Based on these observations, the utopian impulse immediately beckons and the reader might be tempted to conclude (as multiple commentators *have* concluded or summarily assumed) that academic research constitutes a sharing regime that sustains robust innovation without recourse to formal property rights or any other exclusionary instrument[87], precisely as envisioned by the hypothetical construct introduced at the outset. This is standard utopian reasoning: based on the observation that original contributions continue apace despite the absence of any property rights over disclosed knowledge, it is therefore concluded that academic production is solely or primarily supported by reputational norms that rationally induce investments of time and effort by prestige-seeking researchers (as complemented in some cases by intrinsic preferences for the "pursuit of knowledge"). If this is correct, then academic scholarship resisting the extension of property rights to scientific research is on the mark. But both the positive conclusion, and its normative corollary, miss a simple fact: academic research in any

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84 *See* MERTON, *supra* note __, at 291-93; RAVETZ, *supra* note __, at 255.

85 *See* H. Zuckerman, *The Proliferation of Prizes: Nobel Complements and Nobel Surrogates in the Reward System of Science,* 13 THEORETICAL MEDICINE 217 (1992). For further details on other prizes in the academic community, see JAMES F. ENGLISH, THE ECONOMY OF PRESTIGE: PRIZES, AWARDS AND THE CIRCULATION OF CULTURAL VALUE (2005).

86 *See* MERTON, *supra* note __, at 298-300; Fisk, *supra* note __, at 50-51, 84-85.

87 For indicative examples, *see, e.g.,* DOMINIQUE FORAY, ECONOMICS OF KNOWLEDGE 147 (2004) (stating that "open science model" shows that knowledge production can take place in an "IPR"-free zone, although notes that universities must rely on public funding). For similar thoughts that academic research functioned well prior to the advent of intellectual property, which is then viewed as endangering the free dissemination enabled by traditional norms in the research community, see Rai, *supra* note __.

recognizable form is (and has been) supported universally by collateral revenue streams that *are* excludable and are therefore subject to full appropriation by its recipients, which therefore only partially rely on reputational payoffs in electing whether to make innovation investments.

Both historical and contemporary practices in the production of academic knowledge conform to this proposition. At its inception during and shortly after the Renaissance, modern (or premodern) forms of scientific research demanded relatively low levels of capital investment and could subsist on the monetary infusions supplied by aristocratic patrons or the independent resources of gentlemen scholars.[88] In its modern and highly capital-intensive form, scientific research is supported by four principal revenue streams, together amounting to *tens of billions of dollars* annually in the aggregate: (i) cash grants from government agencies or large philanthropic institutions (vitally important in the medical and other hard sciences), and, especially in the U.S. context, (ii) tuition payments by students, (iii) alumni donations, and (iv) part-time or post-career employment in the private sector. The largest component of this funding bundle, federal research grants to academic research, amounted to over $30 billion in 2005, which constituted almost *90*% of total research expenditures at U.S. universities[89]: clearly academic research, at least in the most capital-intensive scientific fields, would largely cease without it. Scholarly commentators in the intellectual-property literature who advance utopian understandings of "pre-property" academic research generally recognize this awkward fact in passing[90] but then fail to observe that it actually demonstrates that any apparently nonproperty model rests on either property-based

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88 For an extensive description of these patronage arrangements, see David, *supra* note __.

89 *See* National Science Foundation/Division of Science Resources Statistics, Survey of Federal Science and Engineering Support to Universities, Colleges and Nonprofit Institutions, FY 2006", avail. at http://www.nsf.org/statistics/nsf07333/pdf/tab1.pdf. Note that this figure does not include state or private contributions to academic research.

90 For an example of an open-access advocate who takes this fact seriously in designing an academic "knowledge commons", see Peter Suber, *Creating an Intellectual Commons Through Open Access,* in HESS & OLSON, *supra* note __, at 175-76. For prior contributions that explicitly recognize the importance of public funding and other capital inflows to sustain scientific research, see Merges, *Scientific Research*, *supra* note __, at 155, and F. Scott Kieff, *Facilitating Scientific Research: Intellectual Property Rights and the Norms of Science—A Response to Rai and Eisenberg,* 95 NW. UNIV. L. REV. 691 (2001). Kieff further observes that scientific researchers have always sought "property rights" in ideas through the recognition accorded to successful projects and, contrary to impressions of an entirely open-access knowledge base, sometimes keep research findings secret for strategic advantage.

appropriation instruments or coercive taxation to compel the necessary contributions to the public good constituted by scientific knowledge.

Properly construed, the university operates as an embedded sharing arrangement that is supported by public-goods contributions from either a coercive taxing authority (i.e., the government) or voluntary philanthropic institutions, which then generates innovation assets that are (i) allied to an educational enterprise that provides an excludable good in the form of teaching services in return for which it receives an excludable stream of cash remuneration from its student clientele and (ii) following the passage of the Bayh-Dole Act in 1980[91] (which permitted universities to patent the results of federally funded research), allied to a licensing enterprise that generates cash returns from licensees of the university's patented technology (which is obviously *not* thrown into the collective innovation pool). So understood, the university is a knowledge-production enterprise that voluntarily participates in a sharing arrangement where it pools some innovation assets with competing institutions for mutual advantage (equivalent to the "sharing core" denoted by the bolded box at the center of the Figure below), which is in turn funded by the property sale of excludable physical and service assets to paying students and corporate licensees. Collateral cash revenues are further supplemented by the fact that some researchers may exit the enterprise partially or entirely and "cash out" accrued human capital by taking up full-time or part-time employment with a for-profit firm.[92] The "free" exchange of knowledge assets, which *appears* to be the key characteristic of academic research, is sustainable as a result of *both* (i) "internal" norm-based governance that allows for the regular allocation of reputational rewards and penalties based on a freely-exchanged body of research findings, and (ii) collateral revenue streams generated by coercive taxation, philanthropic donations and the sale of excludable assets under a "conventional" property-rights regime. *But for* these collateral revenue streams in the form of reputational and monetary credits, the academic research enterprise would be unable to sustain innovation incentives in the face of widespread

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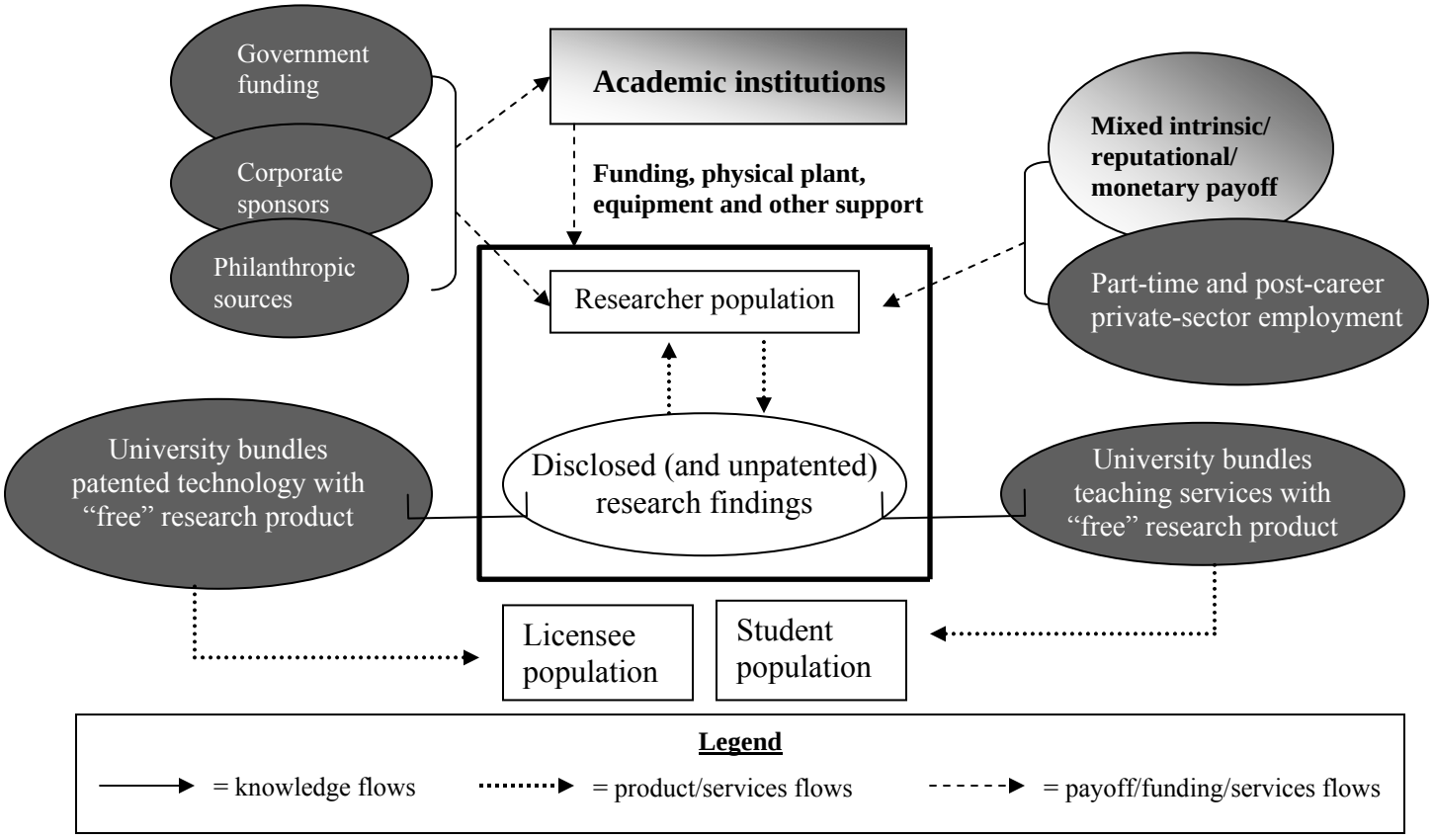
[91] BAYH-DOLE ACT, Pub. L. No. 96-517, 94 Stat. 3019 (1980), codified as amended at 35 U.S.C. §§ 200-211 (2000).

[92] *See* David B. Audretsch & Paula E. Stephan, *Knowledge spillovers in biotechnology: sources and incentives,* in 9 J. EVOL. ECON. 97 (1999) (arguing that researchers cash out human capital in the later stage of their careers by taking up private-sector employment and providing evidence showing that private-sector compensation for pharmaceutical researchers tends to correlate with the researcher's reputational prestige).

institutionalized free-riding by competing researchers, in which case even this consummate sharing regime would be compelled to migrate to a property-based (or somewhat equivalently, a secrecy-based) model, which sustains innovation at high transaction costs (as exist in corporate research and existed in part prior to university-based academic research[93]), or degenerate into an open-access commons, which fails to sustain innovation altogether.

**Figure VII: Mixed-Form Sharing Regime in Academic Research[94]**




[93] Hardly speculation: prior to the full development of the modern system of peer-reviewed scientific journals, the history of science is rife with concealment of results or partial communications of new findings in order to preserve returns from research investments, facts consistent with a modified open-access commons. *See* David, *Patronage, supra* note __; RAVETZ, *surpa* note __, at 247-49. Based on the analytical framework set forth above, a ready explanation is at hand for these earlier practices: without a robust funding mechanism to close the incentive shortfall, researchers rationally declined to make valuable contributions to a shared innovation pool from which commensurate withdrawals were not clearly forthcoming.

[94] Consistent with prior usage, darker coloration denotes practices indicative of a property regime; lighter coloration denotes practices indicative of a sharing regime; intermediate coloration denotes mixed practices indicative of both regimes.

3. Open-Source Software

Open-source software[95] is an industry segment where software products and the corresponding source code (i.e., the human-readable instructions that compose a computer program) are released at no fee (other than occasionally a fee set equal to distribution cost) with relaxed contractual restrictions on use and distribution[96] and then subsequently improved by "volunteer" programmers (the reason for the quotation marks will soon become clear).[97] In an open-source environment, the principal recourse to the state-provided property regime arises insofar as open-source software is released subject to contractual licenses that require inclusion of the developers' copyright notice (for attribution purposes) and sometimes (as in the case of the most widely-used "GNU General Public License" (GPL) license and variants thereof[98]) obligate the user to distribute any derivative applications under the same "open source" terms as the original license, which effectively bars or substantially complicates commercial distribution of derivative applications (other open-source software uses the Berkeley Software Distribution ("BSD") license or close variants thereof, which do not impose these constraints on subsequent distributions).[99] Counterintuitively, the more "open" GPL

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95 The scholarly literature is already extensive and growing quickly. For a critical overview, see Stephen M. Maurer & Suzanne Scotchmer, *Open Source Software: The New Intellectual Property Paradigm,* Nat'l Bureau of Econ. Research, Working Paper #12148 (March 2006). For another earlier literature review, see Maria Rossi, *Decoding the Free/Open Source (F/OSS) Software Puzzle: a survey of theoretical and empirical contributions* (working paper 2004, avail. at http://opensource.mit.edu/papers/rossi.pdf). For a broad book-length overview of the industry and its importance for rational-choice understandings of cooperative behavior, see STEVEN WEBER, THE SUCCESS OF OPEN SOURCE (2004). For a recent collection of scholarly contributions (including an extensive bibliography), see PERSPECTIVES ON FREE AND OPEN SOURCE SOFTWARE (eds. Joseph Feller et al. 2005). For a widely-known popular history of the industry, see ERIC RAYMOND, THE CATHEDRAL AND THE BAZAAR: MUSINGS ON LINUX AND OPEN SOURCE BY AN ACCIDENTAL REVOLUTIONARY (1999).

96 By contrast, proprietary software is released in non-human-readable object-code form (which is a translation of source code made using compiler software) for a fee and under strict contractual restrictions on use and distribution.

97 That is a simplified definition; as described below, actual market practice in the terms of open-source software licenses can vary considerably. However, the industry generally relies on an "official" definition supplied by the Open Source Initiative, which effectively sets a minimum threshold that must be satisfied by any OSI-certified license. For more information, see "OSI—The Open Source Definition", http://www.opensource.org/docs/definition_plain.php.

98 *See* FREE SOFTWARE FOUNDATION, GNU GENERAL PUBLIC LICENSE, avail. at http://www.fsf.org/copyleft/gpl.html.

99 *See* WEBER, *supra* note __, at 179-85. Other commentators note that even "open source" licenses that do permit commercialization in practice follow community norms that encourage free re-distribution in the manner contemplated by a "GPL"-style (or "copyleft") license. *See* Bessen, *Open Source Software,*

license relies more heavily on state-provided contract law in order to deter individually rational defections into the surrounding property regime: it bars exclusive distribution of derivative applications of any open-source code because its proponents correctly anticipate that this would effectively constitute a withdrawal of assets from the shared innovation pool, which would ultimately undermine incentives by other innovators to make further contributions, thereby precipitating project failure.

Under any of the standard licenses, the open-source model exhibits much of the characteristics of a sharing regime insofar as it generates a common innovation pool in the form of unprotected code, to which participant developers regularly make contributions and from which other developers and end-users make withdrawals, in each case at minimal transaction costs given the voluntary waiver of most (but, critically, not all) property-rights protections. Historically, this model is a modified continuation of the informal culture at the university computer science departments and quasi-academic corporate research labs where software development was initially launched, which were characterized by reputation-driven "hacker" norms that encouraged sharing among programmers and rewarded original contributions. While the overwhelming majority of the U.S. software industry taken as a whole operates (and thrives) under the state-provided property regime in the form of patent and copyright protections, a significant "open source" minority in certain segments (for the most part, outside the retail end-user market) now provides products and services under the alternative open-source model, which has developed such widely used applications as the GNU/Linux operating system (used by some corporate and government entities), the Apache web server (which currently runs most internet websites), the Perl programming language, the SendMail internet e-mail engine (which is used to send a large portion of e-mail traffic over the internet) and the Mozilla web browser.[100] Even Microsoft has evinced admiration for the open-source model in an (inadvertently released) internal memo: "The intrinsic

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*supra* note __. For a detailed description of the various types of licenses, see LAWRENCE ROSEN, OPEN SOURCE LICENSING: SOFTWARE FREEDOM AND INTELLECTUAL PROPERTY LAW (2005); MARTIN FINK, THE BUSINESS AND ECONOMICS OF LINUX AND OPEN SOURCE (2003).

[100] See Ronald J. Mann, *Commercializing Open-Source Software: Do Property Rights Still Matter?*, 20 HARV. J. L. & TECH. 1, 9-10 (2006).

parallelism and free idea exchange in OSS [*open-source software*, J.B.] has benefits that are not replicable within our current licensing model."[101]

In some popular, trade, business and scholarly discussions, these market successes have been used to support the claim that innovation incentives in the software industry may be sustainable without bearing the high transaction-cost structure of a fully deployed property regime (or some other exclusionary barrier that limits access by unauthorized third parties) [102], which appears to have been the case prior to the introduction of copyright and then patent protection for software in the U.S. and is still partially the case in Europe, where intellectual-property protections for software are still not as robust. But any utopian view of the open-source segment as a "stand alone" environment that prospers without property or other imitation barriers seriously misunderstands the complexity of the development, distribution, governance and organizational structures at use in this market. As can get lost in enthusiasm over what appears to be a weakly-propertized but economically sustainable environment for innovation investment among a large mass of voluntary contributors[103], the open-source model must confront and resolve the basic dilemma of any sharing regime: in the absence of restrictions on third-party use and distribution (and, hence, any direct remuneration for original contributors), it must provide meaningful incentives to elicit contributions from innovators who rationally demand returns in excess of development costs. This requires taking action to regulate membership size and composition in any open-source project, which in turn sustains a roughly equal parity between contributions and withdrawals from the shared innovation pool (as corrected by side-payments or the equivalent thereof), thereby yielding a

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101 *See* Vinod Valloppillil, *Open Source Software: A (New?) Development Methodology* (Aug. 1998), as quoted in WEBER, *supra* note __, at 127.

102 For the leading scholarly statement of this position in the legal literature, see BENKLER, *supra* note __; Benkler, *Coase's Penguin, supra* note __. For similar views, see James Boyle, *The Second Enclosure Movement and the Construction of the Public Domain,* 66 J. L. & CONTEMP. PROBS. 33, 45-46 (2003).

103 For a review of the literature and a similar observation, see Joseph Lampel & Ajay Bhalla, *The Role of Status Seeking in Online Communities: Giving the Gift of Experience* (working paper 2007) (observing that "a fascination with the utopian aspects of virtual communities has strongly influenced research in this area", which tends to be "highly attuned to features of virtual communities that highlight egalitarian and altruistic motivation"). For a critical description of utopian approaches to open-source software, see Robert L. Glass, *Standing in Front of the Open Source Steamroller,* in PERSPECTIVES ON FREE AND OPEN SOURCE SOFTWARE, *supra* note __, at 84-85.

cooperation payoff in the form of reputational and/or monetary benefits that elicits rational migration from the surrounding property regime.

This expectation is fully consistent with actual practice. Open-source projects are sometimes mis-described as operating in the form of a mass-collaboration enterprise among hundreds to even thousands of diversely knowledgeable individual participants that somehow converges on a spontaneous order.[104] The unusually lavish scholarly attention devoted to the open-source market in its short history has yielded virtually the opposite conclusion. Contrary to widespread perceptions of a collective brain supported by altruistic contributors, almost every empirical researcher who looks "behind the curtain" has found that open-source projects (or more precisely, the small minority of *successful* projects among the thousands of abandoned projects) are typically maintained largely by a core small-number group of experienced developers (to which entry is often strictly constrained through internal control hierarchies) who exhibit high levels of technical sophistication and operate subject to reputational and other norm-governed pressures that elicit high effort.[105] Hence, while the Apache web server is used directly or indirectly by a broad pool of firms and other users, the maintenance and enhancement process is controlled by approximately 25 core developers, subject to formalized review

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[104] Some commentators go so far as to view open-source (and other highly partitioned environments for online contributions) as a novel organizational form. For the most well-known example in the popular literature, see RAYMOND, *supra* note __, and for somewhat more nuanced versions in the legal literature, see BENKLER, *supra* note __, at 66; Benkler, *Cooperative Nicely, supra* note __, at 332-39; Benkler, *Coase's Penguin, supra* note __, at __; James Boyle, *The Second Enclosure Movement and the Construction of the Public Domain,* 66 J. L. & CONTEMP. PROBS. 33, 45-46 (2003).

[105] *See* WEBER, *supra* note __, at 70-71; RAYMOND, *supra* note __, at 89, 123-126; Rossi, *supra* note __; FINK, *supra* note __; Lik Miu et al., *A Group and Reputation Model for the Emergence of Voluntarism in Open Source Development* (Working Paper 2007); Andrea Bonaccorsi & Cristina Rossi, *Why Open Source software can succeed,* 32 RES. POL'Y 1243 (2003); Charles M. Schweik, *Free/Open-Source Software as a Framework for Establishing Commons in Science,* in HESS & OSTROM, *supra* note __, at 285. *See also* Karim R. Lakhani & Robert G. Wolf, *Why Hackers Do What They Do: Understanding Motivation and Effort in Free/Open Source Software Projects,* in PERSPECTIVES ON FREE AND OPEN SOURCE SOFTWARE, *supra* note __, at 35 (noting that measures of source-code authorship show that a few individuals are responsible for disproportionately large fractions of the total code base and referencing other studies that reach similar results). For membership and screening procedures as described in great detail with respect to the Debian project (a "free" Linux installation package), see Fabrizio Ferraro & Siobhan O'Mahony, *Managing the Boundary of an 'Open' Project* (Harvard NOM Research Paper No. 03-60, 2004) (noting that contributors to open-source projects must provide "joining scripts" to show commitment to the project and describing crypotographic and other technical tools used to regulate access to the code base), and for a similar study with respect to the Freenet project, see Georg von Krogh et al., *Community, joining script and specialization: a case study*, 32 RES. POLICY 1217 (2003) (describing detailed admission requirements and apprenticeship and similar training periods to regulate admission into "core" developer group).

and approval procedures to ensure system integrity (while larger groups of users submit "problem reports").[106] Likely reflecting in part the disproportionate costs borne by these small groups of dedicated developers, open-source projects often fail to achieve scale beyond an initial "pioneer" effort, resulting in a high abandonment rate[107] (a fact sometimes obscured by widespread references to the tens of thousands of "registered" open-source software projects), a result not unanticipated in the case of a sharing regime that lacks an exclusionary mechanism to assure remunerative streams that reflect differential contributions by individual participants.

Now of course this observation still does not immediately rule out the utopian scenario (although high failure rates should immediately cast some doubt) since it fails to identify any rational support for the costly investments of time and effort even by these smaller groups of dedicated programmers in the small minority of successful open-source projects, which therefore appear to operate on a largely or purely voluntary basis. But two further observations show this anomaly to be substantially overstated. First, there simply is no puzzle at all with respect to roughly half of all open-source programmers, who are employed or sponsored by for-profit software incumbents or not-for-profit foundations (usually sponsored by for-profit companies).[108] Second, available survey evidence tends to suggest that even unpaid programmers are motivated by a miscellany of

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106 See Audris Mockus et al., *Two Case Studies of Open Source Software Development: Apache and Mozilla,* in PERSPECTIVES ON FREE AND OPEN-SOURCE SOFTWARE, *supra* note __, at 171-75. For similar, more general observations, see ROSEN, *supra* note __, at 43-45; RAYMOND, *supra* note __, at 126. *See also* Mui et al., *supra* note __ (noting that the most successful open-source projects tend to restrict the size of the core developer group); Bonaccorsi & Rossi, *supra* note __ (referencing studies of contributions to the Apache, GNOME and other active open-source projects, which all show heavy concentration of contributions among core group of developers).

107 *See* Brian Fitzgerald, *Has Open Source Software a Future?*, in PERSPECTIVES IN FREE AND OPEN SOURCE SOFTWARE, *supra* note __, at 96-97 (using sample of over 400 registered open-source project, observing hat most projects have two or fewer developers and the vast majority appear to be abandoned); Mockus et al., *supra* note __, at 187 (noting that open-source projects sometimes fail to scale because core developers cannot handle and coordinate the quasi-administrative tasks of finding and repairing defects, resulting in a code of suboptimal quality).

108 *See* Rishab Aiyer Ghosh et al, *Survey of Developers, Free and Open Source Software* (Working Paper 2002); Maurer & Scotchmer, *supra* note __. *See also* WEBER, *supra* note __, at 68-69 (noting that most developers involved in open-source projects appear to come from the private-sector rather than the academic sector); and Lakhani & Wolf, *supra* note __, at 4-21 (based on survey of 684 software developers, finding that 40% of the sample received direct financial compensation from employer for participation in open-source projects). Most current participants in open-source software arrangements are for-profit firms. *See* James Bessen, *Open Source Software: Private Provision of Complex Public Goods* (Working Paper July 2005).

factors, including intrinsic interest in intellectual enjoyment, need for a customized program that did not yet exist in the market, the opportunity to improve programming skills, and, as some researchers emphasize, reputational capital and resulting improved career prospects.[109] The potential reputational value attached by individual contributors to participation in high-profile open-source projects is illustrated by the fact that most projects have highly detailed attribution procedures—akin to the citation technology in the academic context—to apportion credit to contributing programmers, presumably in part for "ego" reasons and in part because these detailed archival records can then be monetized into improved career prospects with attendant financial benefits. Trade and popular accounts of open-source development describe the important role played by reputational mechanisms as a functional peer-review system that facilitates trust among contributing developers in any given project, who bestow praise on a strong programmer and stigmatize and even shun a weak programmer from further participation, thereby excluding a differentially-endowed contributor that would endanger the reciprocal exchange of knowledge assets among participating programmers.[110] This is certainly not to deny that some programmers are motivated partly or even principally by payoff-insensitive ideological or other "heroically" noninstrumental considerations[111], but it does not appear that it can reasonably be described as the prevailing motivating factor that

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[109] For studies that emphasize reputational effects, see Eric von Hippel & Georg von Krogh, *Open Source Software and the Private-Collective Innovation Model: Issues for Organization Science,* 14 ORG. SCI. 209 (2003); Josh Lerner & Jean Tirole, *The Simple Economics of Open Source* (Nat'l Bureau of Econ. Res., Working Paper #7600) (2000). Other studies are more mixed, generally finding weaker support for altruism (e.g.., advancing the "open-source movement") and stronger support for extrinsic incentives such as accrual of reputational capital and improving programming skills and intrinsic incentives such as user-based enjoyment, *see, e.g.,* Wafa Orman & Utteyo Dasgupta, *An experimental analysis of teamwork and open-source software development* (working paper, Nov. 2006), available on www.ssrn.com; Rishab Aiyer Ghosh, *Understanding Free Software Developers: Findings from the FLOSS Study,* in PERSPECTIVES ON FREE AND OPEN SOURCE SOFTWARE, *supra* note __, at 23-46; Lakhani & Wolf, *supra* note __, at 4-21. For a survey of empirical studies, see Rossi, *supra* note __; Bonaccorsi & Rossi, *supra* note __; Siobhan O'Mahony, *Guarding the commons: how community managed software projects protect their work,* 32 RES. POL'Y 1179 (2003).

[110] *See, e.g.*, FINK, *supra* note __, at 27-28, 55, 95; Lakhani & Wolf, *supra* note __, at 7. For similar thoughts on the importance of reputation effects among open-source developers, see RAYMOND, *supra* note __, at 59, 64-65, 97, 108-11.

[111] The obvious example of an ideologically motivated participant is Richard Stallman, the founder of the Free Software Foundation, the ideological pioneer of the open-source "movement", or Bruce Perens, the head of the Open Source Initiative, which maintains threshold standards for certified open-source licenses. For further discussion of the ideological motivations behind some open-source participants (again, especially in the earlier development of this market segment), see RAYMOND, *supra* note __.

drives voluntary participation by most open-source programmers (or more precisely, by the "remainder" pool of unpaid open-source programmers).

Even the incentive effects of reputational utility and its monetizable by-products can be overstated as the key to resolving the "open source puzzle", at least in the current (and now commercially significant) state of the industry. Based on a substantial body of accumulated evidence, it is now clear (contrary to some earlier perceptions of the industry, which curiously linger even in fairly recent contributions in the legal literature) that the sharing arrangements that constitute the most economically significant portions of the open-source software segment are most accurately viewed as a mutually beneficial joint venture among a restricted group of participant firms that follows the standard economic rationales that motivate any multi-entity form of economic organization. It is hard to underestimate the financial contribution made by *proprietary* software companies to facilitate market adoption of open-source's largest successes to date. Large-firm software incumbents provide substantial operational funding for the most high-profile open-source projects and, in some cases, contribute employees to supply programming expertise to a particular project[112] (IBM employs 600 programmers at the IBM Linux Technology Center to maintain and improve the LINUX operating system[113]), including the approximately $1 billion per year in funding provided to the Linux Foundation (formerly known as the Open Source Development Lab) by major proprietary software and other for-profit companies[114] or the substantial funding provided by HP, IBM and Sun Microsystems for development of the "GNOME" desktop product.[115] Some of these same firms have then sought to protect this investment through formation of an Open Invention Network, a non-profit "patent-sharing" entity that holds patents to open-source technologies so as to preclude "hold-up" by third-party claimants.[116] The profit-

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112 *See* Daniel M. German, *Software Engineering Practices in the GNOME Project,* in PERSPECTIVES ON FREE AND OPEN-SOURCE SOFTWARE, *supra* note __, at 212.

113 *See* David Kirkpatrick, *IBM Shares Its Secrets,* Fortune, Sept. 5, 2002, avail. at http://www.cnnmoney.com.

114 *See* Mann, *Open Source, supra* note __, at 24. For further information, see http://www.linux-foundation.org/en/Main_Page.

115 *See* FINK, *supra* note __, at 70.

116 *See* Ronald J. Mann, *Commercializing Open-Source Software: Do Property Rights Still Matter?*, 20 HARV. J. L. & TECH. 1, 20 and 27 n.110 (2006).

maximizing objectives behind these substantial investments in forming collective pools of technical knowledge are three-fold: (i) lower development and debugging costs through a collective quality-improvement mechanism that effectively allocates highly modularized assignments to a mass of sophisticated users[117], (ii) reduce reliance on proprietary software vendors (e.g., Microsoft); and/or (iii) promote an installed base to which property applications, property hardware and/or packaging, support and documentation services can then be supplied.[118] Following the logic of a sharing regime, any rational-choice anomaly disappears: each participant repeat-player firm incurs short-term cooperation costs (principally, losses attributable to "altruistic" disclosure of the source code and lost employee time or, in the case of an individual, lost time and related opportunity costs) in exchange for anticipated cooperation gains in the form of reduced development and/or promotion costs (or, in the case of an individual, increased reputational capital for recognized programming ability and related career prospects).

Large software firms that support open-source software projects, and which normally operate on the basis of a fully property business model, have effectively invested as a consortium in the development of a common open-access infrastructure that will in turn support the provision of differentiated derivative products under an allied property model, which will in turn generate an excludable profit stream that is anticipated to exceed immediately incurred "build-out" costs and other expenditures. This is simply a standard "loss leader" strategy played out at a high level of sophistication: the Linux operating system is a commodity software product that firms develop and then "give away" in order to sell property products and services for which a premium can then be

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117 Yochai Benkler in particular emphasizes the critical role of modularity (and more precisely, the ability to allocate work assignments in a modular fashion at low per-user costs) in facilitating peer-production forms of organization under conditions of excess capacity in certain classes of goods, which he argues generalizes across a broad class of economically significant activities. *See* Benkler, *supra* note __. At this stage, this original hypothesis appears to be at best an open empirical proposition pending further market exploitation of this business model. That is especially the case given that open-source software, perhaps the leading empirical illustration cited by Benkler, appears (at least in its most commercially successful forms) to rely primarily on a conventional exclusionary model to sustain innovation investment.

118 *See* WEBER, *supra* note __, at 74-76; James Bessen, *Open Source Software: Private Provision of Complex Public Goods,* in J. BITZER ET AL., THE ECONOMICS OF OPEN SOURCE SOFTWARE DEVELOPMENT (2006). For additional discussion of business models in the open-source market, see Aaron Schiff, *The Economics of Open Source Software: A Survey of the Early Literature,* 1 REV. NETWORK ECON. 66 (2002); Chris Nosko et al., *Open Source and Proprietary Software: The Search for a Profitable Middle Ground* (Working Paper 2005); FINK, *supra* note __; ROSEN, *supra* note __; Raymond, *supra* note __, at 155-169.

demanded from customers. These hybrid leveraging strategies have already borne fruit for some corporate sponsors or collateral service providers: given the technical sophistication required to use and implement open-source software applications, for-profit distributors and servicers derive profits by delivering property packaging, support, updating and other services to be used in connection with otherwise freely available open-source applications.[119] In turn, the large market for Linux-based operating systems generates business for IBM (the largest corporate sponsor of Linux) and other firms that sell hardware that runs on the Linux operating system, together with associated service, support and consulting services. Note that it is precisely the fact that the Linux platform is situated in a collective innovation pool that enables each individual producer to offer differentiated products that in turn generate a remunerative stream following a conventional property model. In an alternative "dual-licensing" business model, some firms use open-source code as the platform on which to launch a complementary property hardware or software product.[120] Both generic models are depicted graphically below: in each case, an unprotected "sharing core" characterized by the free-exchange (and partially reputation-driven) practices typical of a sharing regime (denoted by the box in bold) is allied with complementary revenue streams that are protected by a legal or extralegal exclusionary instrument typical of a "conventional" property regime.

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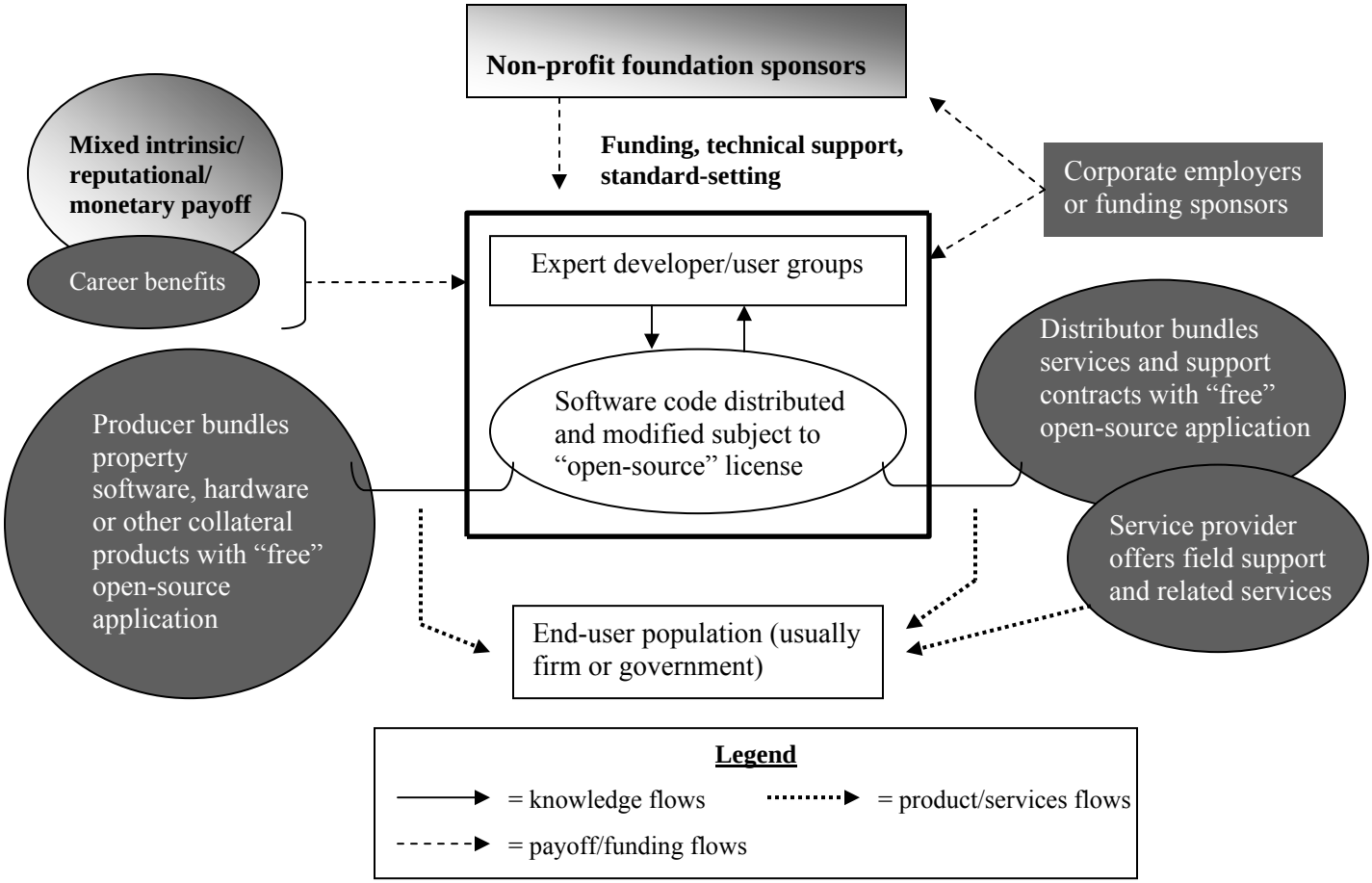
[119] *See* WEBER, *supra* note __, at __; Fink, *supra* note __, at 178-180; Mann, *Open Source, supra* note __, at 10-14. The market demand for these collateral services is clearly illustrated by Linux: of the more than estimated 35 million copies in use, more than half are estimated to have been purchased (rather than downloaded for free), such that the boundaries between open and proprietary software are at least blurred. *See* FINK, *supra* note __, at 4 (citing estimates by IDC, a research organization).

[120] MySQL, a database application provider, is the leader in this market segment (and now a subsidiary of Sun Microsystems). There are numerous other examples. For further discussion of dual licensing business models, see Nosko et al., *supra* note __; Schiff, *supra* note __; FINK, *supra* note __; ROSEN, *supra* note __; West & Gallagher, *supra* note __.

**Figure VIII: Mixed-Form Sharing Regime in Open-Source Software**[121]




[121] Consistent with prior usage, darker coloration denotes practices indicative of a property regime; lighter coloration denotes practices indicative of a sharing regime; intermediate coloration denotes mixed practices indicative of both regimes.

This generic taxonomy of three service-based and/or product-based appropriation strategies set forth in the Figure above is an expedient simplification. The open-source software market actually consists of a diverse menu of multiple licenses (of which there exist about 50 variants[122]) and myriad product/service combinations, each of which offer developers and/or users a fine variety of hardware, software and service bundles composed of multiple open-source and closed-source or other property components.[123] Given the extensive use of collateral remuneration streams to sustain contribution rates to the shared innovation pool constituted by any open-source project, this Article's basic proposition is confirmed: any sharing regime that sustains economically significant investment must make recourse to the state-provided property system, or some other effective exclusionary instrument, in order to sustain contribution incentives by rationally self-interested agents. Hence, the impressive penetration of the Linux operating system may be due not only to its technical performance but to the fact that its largely non-ideological proponents have tolerated the growth of an allied set of for-profit intermediaries that have rationally invested in allied services and products that promote its wider dissemination in the market.[124] Utopian commentators are correct to observe the impressive market penetration achieved by the Linux operating system, but misunderstand this fact as evidence that exclusionary protections are not a necessary prerequisite to innovation investment; properly understood, this fact is evidence for the necessity of coupling any "free" intellectual asset with a "subscription" product or service component to support any rational production model. Whereas a property regime elicits contributions by directly using state-provided property rights to exclude non-contributing outsiders, thereby limiting positive externalities that would otherwise reduce contribution incentives, a complex sharing regime achieves an equivalent outcome by using selective incentives in the form of (i) at the individual level, reputational capital and related career benefits, and (ii) at the firm level, collateral product and services revenues, each of which are at least indirectly reliant on state-provided property rights that extend to an allied

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122 *See* ROSEN, *supra* note __, at 1.

123 *See* Mann, *Open Source, supra* note __. For a more detailed discussion, see FINK, *supra* note __, at Ch. 11; Joel West & Scott Gallagher, *Patterns of Open Innovation in Open Source Software,* in OPEN INNOVATION: RESEARCHING A NEW PARADIGM (eds. Henry Chesbrough et al. 2006).

124 *See* RAYMOND, *supra* note __, at 85-86.

revenue-generating asset (labor in the case of (i); products or services in the case of (ii)). The open-source phenomenon demonstrates the meaningful ability of reputational incentives (and related career benefits) to elicit certain levels of voluntary contributions to the innovation pool; however, it equally demonstrates that, to sustain innovation projects that can scale to commercial useful levels, these reputational incentives must be accompanied by the conventional lure of monetary and other material benefits, which in turn necessitates recourse to *some other* legal or extralegal exclusionary protections.

This outcome is fully anticipated by this Article's fundamental thesis: beyond small-number, low-capital-intensity and endowment-homogeneous settings, any sharing community that relies solely on a norm-driven sanction and reward apparatus is inherently unstable and will be compelled to make some recourse to state-provided or some other robust exclusionary entitlements. Hence, contrary to the tenor of some scholarly commentary (but fully consistent with the prevailing findings in empirical research), the open-source market poses a relatively minor "puzzle" (if at all) for standard rational-choice models of intellectual production. While an open-source project makes little recourse to the surrounding property regime to limit access to the innovation pool, it elicits contributions—and thereby overcomes any free-rider threat—by supplying an appropriation platform that can then generate demand for secondary products or services to which access *will* be limited following a standard property-based model. As such, the open-source model is best understood not as an entirely novel organizational form but as the most recent installment in an ongoing sequence of various combinations of sharing and property regimes over a broad range of market settings and historical periods whereby innovator populations seek to secure investment returns in the face of imitation while minimizing the transaction-cost burdens that attend a formal property-rights regime. The true novelty of the open-source model lies in the fact that it represents a highly sophisticated tradeoff, at impressively high levels of capital investment, between the low transaction-cost burden of a sharing regime (mitigated by relaxed licensing of a common software platform) and the high innovation incentives of a property regime (sustained through remunerative streams from the sale of collateral products and services protected by robust property-rights entitlements). That structural feat—rather than the largely minor puzzle of small groups of (sometimes paid) programmers' willingness to

make "voluntary" contributions to a public good—is a question worthy of serious and profitable inquiry.

### Conclusion: Channeling the Utopian Impulse

I set out to formulate and then assess a broadly representative and analytically useful version of the utopian thesis: specifically, the view that innovation markets can and do operate vigorously by recourse to reputation-driven norms in lieu of formal intellectual-property protections or other exclusionary barriers. This intuition is normatively attractive and, presumptively, has some respectable factual grounding: casual empiricism identifies innovation markets that thrive with little intellectual-property and a great deal of rapid imitation; multiple case studies document the regulatory force of social norms in selected innovation markets; law-and-economics scholars and, in the common-pool resource context, political scientists and institutional economists, have confirmed the regulatory force of social norms (in lieu of legal instruments) in multiple settings. But a combination of theoretical and empirical analysis shows that the *observation* that some innovation markets *apparently* proceed vigorously without intellectual-property protections does not so easily yield the *conclusion* that economically-intensive forms of innovation can be sustained without some legal or exclusionary barrier against imitation. Simple application of theoretical models of rational-choice incentives anticipates that this utopian model has a narrow scope of application: that is, only under strict parameters is it plausible to believe that innovation investment will proceed without some robust barrier, legal or otherwise, against imitation. In a certain respect, this "discovery" is entirely unsurprising, for it is simply an extended application of the well-known claim that private contributions to a collective good in large-number settings will inevitably fail in a broad range of circumstances in the absence of material incentives to reward contributors and material sanctions to deter non-contributors. Empirics conform to these claims with remarkable accuracy (or, to say the same thing, theory shows a tight explanatory fit with empirics) and diverge markedly from the utopian thesis and related variants. Substantially consistent with theoretical expectations, a novel overview of actual sharing regimes shows, across a variety of periods and industries, that any apparently open-access environment for intellectual

production either (i) tends to support economically insubstantial levels of innovation investment or, more commonly, (ii) actually does rely on some other exclusionary barrier, usually in connection with an allied product or service component that generates a positive remunerative stream to reward innovation investment. In other words: either the exception proves the rule or, even more commonly, the exception turns out to follow the rule!

This line of argument confines the scope of application of the utopian thesis to small-scale or "little IP" environments characterized by low capital-intensity, low endowment heterogeneity and small group size—*if, but only if*, it is taken to stand for the strong proposition that sharing regimes can *independently* sustain innovation incentives without any, or any substantial, limitations on third-party access to the relevant product bundle. However, more constructively for purposes of future research, this line of argument exposes a far broader landscape of large-scale or "big IP" environments in which to expect that sharing practices will flourish and play a significant role as embedded mechanisms for alleviating the transaction-cost burdens that attend an extensively-deployed property regime. At least in the modern economic context that typically involves substantial capital investments, it is of greater practical interest to adopt the following intermediate proposition: (i) sharing regimes confer substantial collective gains in the form of reduced transaction-cost burdens but (ii) outside of limited settings, are unstable and unlikely to persist unless supplemented by state-provided property rights or some other exclusionary mechanism of functional equivalence. This nuanced thesis explains both why (i) "stand alone" sharing regimes tend to be confined to low-capital-intensity activities that sometimes stand at the margins of economic activity, but (ii) sharing practices and other nominal-cost exchange arrangements *do* persist in "embedded form" in a variety of partly to substantially propertized market segments in impressively broad portions of the high-technology industries that operate at the heart of the current information-based economy. It is easy to see why the utopian mirage beckons so strongly: there do *appear* to be sharing communities that apparently sustain innovative output without robust legal barriers against imitation. However, sustained examination mostly (but critically, not entirely or at least not straightforwardly) bears out the wary intuitions of the rational-choice skeptic: these communities typically are only

able to achieve this sharing outcome in low capital-intensity settings that tend to lie on the fringe of technological and creative production; where this condition is not satisfied, then there is almost always some meaningful recourse to formal property rights or some other access barrier to shield innovation returns.

This view is fully consistent with the law-and-economics literature on social communities that maintain "order without law" and the social science literature on "limited-access commons regimes" that (purportedly) solve or ameliorate public-goods problems without recourse to state enforcement. Where scholars have identified settings where norms successfully operate in lieu of law (consider: Shasta County ranchers[125], New York diamond merchants[126], Maine lobstermen[127], etc.), this tends to occur in small-number communities consisting of a restricted membership of repeatedly-interacting players with similar endowments and interests. But what works in the "village" on the outer boundaries of the modern economy will not work so well in the "city" that lies at its heart: that is, these conditions are by definition *unsatisfied* by innovation markets of economic significance in contemporary settings involving large numbers of differentially-endowed agents and high capital-investment requirements, which must therefore make recourse to exclusionary instruments in order to sustain innovation incentives. But the staying power of property in innovation markets does not banish sharing practices to the outer fringes of intellectual-property scholarship. To the contrary: mechanisms for the nominal-cost exchange of intellectual-property assets rationally persist at the very heart of innovation markets that widely implement state-provided property rights. Just as rational self-interest inexorably defeats any stand-alone sharing regime as it attempts to scale up to economically intensive settings, rational self-interest necessarily drives the formation and maintenance of sharing arrangements to lower the transaction-cost burden attendant to a formal property-rights regime. This proposition yields in turn two foundational principles. Contrary to standard utopian expectations, *property arrangements are a complement to sharing arrangements*: that is,

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125 *See* ELLICKSON, *supra* note __.

126 *See* Lisa Bernstein, *Opting Out of the Legal System: Extralegal Contractual Relations in the Diamond Industry,* 21 J. LEG. STUD. 115 (1993).

127 *See* JAMES M. ACHESON, THE LOBSTER GANGS OF MAINE (1988).

it is only by recourse to property rights or some other exclusionary instrument that sharing arrangements can stably persist in economically intensive markets characterized by endowment heterogeneity, large numbers and high capital-intensity requirements. And, contrary to standard incentive-based views, *sharing arrangements are a complement to property arrangements:* that is, it is only by recourse to sharing arrangements that innovator populations can substantially alleviate the transaction-cost burden inherently imposed by formal property rights or other exclusionary barriers.