

**MODULARITY IN PROPERTY,
INTELLECTUAL PROPERTY, AND ORGANIZATIONS**

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INTRODUCTION

At the center of the New Institutional Economics (NIE) is the problem of measurement, because without measurement of the attributes of activities and resources, economic actors cannot use or trade them without loss. In a world without transaction costs, making measurement costless and uninteresting. It is in our world of scarce resources, including resources for acquiring and acting on information, where measurement becomes an issue. And this scarcity problem makes the methods of measurement a source of explanation for the patterns of behavior we see. Some of these patterns involve what NIE calls “property rights,” and these in turn include “property” in the sense of property law.¹ In this paper I will argue that some very basic devices used to economize on information form the foundation not just of property law itself but also that property-like element that lies at the heart of organizations and intellectual property as well.

What is this basic property element? I have argued elsewhere that the starting point in property is an *exclusion* strategy, which employs rough proxies like boundaries in order to protect a wide range of unspecified uses.² If I see cars in a parking lot, I know not to take one, regardless of who the owner is or what he plans to do with the car.³ Likewise, the fence around Blackacre and the right to exclude others from it protect a wide range of interests in use (e.g., building, growing crops, etc.) without the law needing most of the time to make direct reference to those uses.⁴ Because most of these uses need

¹ See, e.g., Armen A. Alchian, *Some Economics of Property Rights*, in ECONOMIC FORCES AT WORK 127, 130 (1977) (reprinting 30 IL POLITICO 816 (1965)) (“By a system of property rights I mean a method of assigning to particular individuals the ‘authority’ to select, for specific goods, any use from a nonprohibited class of uses.”); Harold Demsetz, *Toward a Theory of Property Rights*, 57 AM. ECON. REV. (PAPERS & PROC.) 347, 347 (1967) (“An owner of property rights possesses the consent of fellowmen to allow him to act in particular ways.”); see also THRAINN EGGERTSSON, ECONOMIC BEHAVIOR AND INSTITUTIONS 33 (1990) (stating that “[w]e refer to the rights of individuals to use resources as *property rights*” and quoting Alchian’s definition); Steven N. S. Cheung, *The Structure of a Contract and the Theory of a Non-Exclusive Resource*, 13 J.L. & ECON. 49, 67 (1970) (“An exclusive property rights grants its owner a *limited* authority to make decision on resource use so as to derive income therefrom.”).

² Henry E. Smith, *Exclusion versus Governance: Two Strategies for Delineating Property Rights*, 31 J. LEGAL STUD. S453 (2002).

³ J.E. PENNER, THE IDEA OF PROPERTY IN LAW 75-76 (1997).

⁴ See, e.g., J.W. HARRIS, PROPERTY AND JUSTICE 63 (1996); Penner, *supra* note 3, at 68-74.

not be separately specified or even known to outsiders, the exclusion strategy serves to economize on information, or, more strictly, speaking, to economize on scarce human attention.⁵ Only when resource conflicts involve high stakes does it make sense to narrow in on specific uses, through a *governance* strategy. Under a governance strategy some rights are defined more directly in terms of proper use: a person has a right to perform a certain action, and the action rather than some defined thing is the focus of delineation effort.

Much of nuisance law is a classic example of this governance approach: certain activities like emitting odors are the focus of attention, and contextual factors about the neighborhood and the relative benefits to society of the conflicting uses are directly relevant. The paradigm for the shift from exclusion to governance is the law of trespass and nuisance;⁶ as one moves outward from core trespass deeper into the law of nuisance the focus of property rights delineation shifts from questions of boundary invasion to the specific harms and benefits stemming from and impacting the competing uses of the parties. These refinements can be accomplished through contract, off-the-rack tort law (e.g., nuisance), or regulation (e.g. zoning).

In the NIE, governance rules would count as property rights and there would be nothing special about exclusion, but I will argue that the exclusion approach is itself an economizing move. First, exclusion serves as a shortcut for over a more articulated set of detailed governance rules. Our interactions can be relatively anonymous precisely because they are mediated by a thing—the cars in the example above. The focus on exclusion—for reasons of simplicity and cheapness—only makes sense because of positive transaction costs—here broadly taken to include the nonzero cost of delineating property rights.⁷ In a world of zero transaction costs we might accept for all purposes the

⁵ Herbert A. Simon, *Designing Organizations for an Information-Rich World*, in *Computers, Communication, and the Public Interest* 37, 40-41 (Martin Greenberger ed., 1971).

⁶ *See, e.g.*, Merrill, *Trespass*, *supra* note 3; Smith, *supra* note 15; *see also* *Victoria Park Racing and Recreation Grounds Co. v. Taylor*, (1937) 58 C.L.R. 479 (Australia) (Evatt, J., dissenting) (describing the law of nuisance as “an extension of the idea of trespass into the field that fringes property”), citing 1 THOMAS ATKINS SWEET, *FOUNDATIONS OF LEGAL LIABILITY (Theory and Principles of Tort)* 211 (1906).

⁷ *See, e.g.*, Douglas W. Allen, *What Are Transaction Costs?*, 14 *RES. L. & ECON.* 1 (1991) (arguing that transaction costs are better defined as the costs of establishing property rights, in the economist's sense of a

economists' definition of a property right as a right to take one of a list of actions with respect to a thing, the thing being merely a backdrop to the direct specification of what actions are permissible as between any pair of members of society.⁸ But in our positive-transaction-cost world, specifying all the actions each actor in society may take with respect to each other is not cost-effective.

Second, mixing exclusion with governance manages the complexity of actors' interactions through its modularity. A complex system is one in which internal interactions are many and multiplex such that it is difficult to infer the properties of the whole from the properties of its parts.⁹ Any change to an element of the system can in principle affect any other element or combination of elements directly or indirectly. The number of possibilities rises exponentially (in the literal sense). So in a fully interconnected system change is so unpredictable though such ripple effects that change may not be an option, leading to rigidity. The choice, in other words, is between near-chaos and rigidity. One way out of this bind is to break up the system into semi-autonomous components (modules). Modularization depends on the system being what Herbert Simon termed "nearly decomposable."¹⁰ A nearly decomposable system consists of a pattern of interactions such that module boundaries can be drawn so that interactions are intense within the module but sparse and constrained between modules. This allows for information hiding: decisions in one module can be made largely without regard to what is happening in other modules, with the only constraint being the satisfaction of the interface conditions. Modularity has been a key concept in many areas ranging from evolutionary biology to cognitive science, software, and organization theory. To take one example, teams writing software tend to be modular, often reflecting the structure of

de facto ability to derive utility from an action, rather than narrowly as the costs of exchange); Steven N.S. Cheung, *The Transaction Costs Paradigm*, 36 *ECON. INQUIRY* 514, 515 (1998) ("Transaction costs' must be defined to be all the costs which do not exist in a Robinson Crusoe economy.").

⁸ Thomas W. Merrill & Henry E. Smith, *What Happened to Property in Law and Economics?*, 111 *Yale L.J.* 357 (2002).

⁹ HERBERT A. SIMON, *THE SCIENCES OF THE ARTIFICIAL* 195 (2d ed. 1981) (1969).

¹⁰ *Id.* at 195-98 (describing a nearly decomposable system as one "in which the interactions among the subsystems are weak but not negligible"). See also 1 CARLISS Y. BALDWIN & KIM B. CLARK, *DESIGN RULES: THE POWER OF MODULARITY* (2000); *MANAGING IN THE MODULAR AGE: ARCHITECTURES, NETWORKS AND ORGANIZATIONS* (Raghu Garud et al. eds., 2003).

programs.¹¹ In a nonmodular structure, again, any part could potentially impact every other, requiring superhuman efforts at acquiring and tracking information.

Markets have a strongly modular flavor. On Adam Smith's account, each actor only needs consult his self-interest against the background of the market and will be guided as if by an invisible hand towards actions that contribute to efficiency.¹² The informational responsibility of each actor is limited and local. Likewise, Hayek's theory of markets as devices for processing information partakes of what we would call modularity.¹³ Each market actor possesses a variety of local knowledge about that actor's own uses of resources, but need only consult prices in order to make economizing decisions about the acquisition and use of those resources. The information that each actor uses can impact prices but no other actor need know it. The prices are the interface conditions between market participants, and allow other information to be hidden. By contrast, a central planner is nonmodular and is expected to gather and act on all this information, without any interaction between two pieces of information being ruled out in principle. The NIE points to the importance of many institutions for market exchange. In this paper I will suggest that modularity is characteristic one of these supporting institutions: the law of property.

Property law provides for management of much complexity through modularity. The exclusion strategy is the starting point in property, and the effect of this strategy is to economize on information costs. By setting up cheap and rough proxies like boundary crossings, property law can indirectly protect a wide range of largely unspecified interests in use, and the details of those use are of no particular relevance to those who are under a duty to respect the right (in this case by avoiding boundary crossing lacking in

¹¹ See *infra* notes 38-44 and accompanying text.

¹² 1 A. SMITH, AN INQUIRY INTO THE NATURE AND CAUSES OF THE WEALTH OF NATIONS 477 (E. Cannan Ed. 1976) ("As every individual, therefore, endeavours as much as he can both to employ his capital in the support of domestic industry, and so to direct that industry that its produce may be of the greatest value; every individual necessarily labours to render the annual revenue of the society as great as he can. He generally, indeed, neither intends to promote the public interest, nor knows how much he is promoting it. By preferring the support of domestic to that of foreign industry, he intends only his own security; and by directing that industry in such a manner as its produce may be of the greatest value, he intends only his own gain, and he is in this, as in many other cases, led by an invisible hand to promote an end which was no part of his intention.").

¹³ F.A. Hayek, *The Use of Knowledge in Society*, 35 AM. ECON. REV. 519 (1945).

permission). The basic (rebuttable) presumption is property law is delegation to the owner through the right to exclude, which serves to economize on information costs.¹⁴ In effect, the exclusion strategy allows the system of uses of resources to manage complexity with modularity, with much information hidden in property modules. In trespass to land, an unauthorized crossing a boundary serves as a (very) rough proxy for harmful use; any voluntary entry into the column of space defined by the *ad coelum* rule counts as a trespass.¹⁵ Keep out usually means keep out. Thus from the dutyholder's perspective, property is like a black box, a module, in that much information about uses and users is simply irrelevant to the dutyholder's duty of abstention. Only in specialized contexts does the law start inquiring into uses more directly, as where one landowner is annoying another with odors; these governance rules of nuisance law can be thought of as the interface between adjacent bundles of rights.¹⁶ But it is the exclusion factor that keeps the bundles lumpy and opaque, and operating as modules in which interactions and interdependencies are intense inside but sparse across the interface connecting modules. As a result, actions within a module do not have hard-to-predict ripple effects through the entire system. On the information-cost theory, the combination of exclusion and governance in property furnishes modules and interfaces for actors taking potentially conflicting actions with respect to resources.

¹⁴ See Smith, *supra* note 2; see also Henry E. Smith, *Property and Property Rules*, 79 N.Y.U. L. REV. 1719, 1755-73 (2004). This theory differs from those that see the right to exclude as the sine qua non of property, see, e.g., Thomas W. Merrill, *Property and the Right to Exclude*, 77 NEB. L. REV. 730 (1998), and also differs in emphasis from theories that posit a necessarily tighter connection between the mechanism of delineation and the interests in use, see, e.g., Adam Mossoff, *What is Property? Putting the Pieces Back Together*, 45 ARIZ. L. REV. 371, 390-91 (2003) (acquisition, enjoyment, and alienation); RICHARD A. EPSTEIN, *TAKINGS: PRIVATE PROPERTY AND THE POWER OF EMINENT DOMAIN* 61 (1985) (basing property on the Roman and Blackstonian trinity of rights of possession, use, and disposition); Larissa Katz, *Exclusion and Exclusivity in Property Law*, 58 U. TORONTO L.J. 275 (2008) (grounding property in owner's exclusive right of agenda-setting).

¹⁵ The full statement of the maxim is *cujus est solum, ejus est usque ad coelum et ad inferos* (he who owns the soil owns also to the sky and to the depths). The maxim is routinely followed in resolving issues about ownership of air rights, building encroachments, overhanging tree limbs, mineral rights, and so forth, and is subject to certain limited exceptions for airplane overflights, for example. See *Brown v. United States*, 73 F.3d 110, 1103 (Fed. Cir. 1996); Thomas W. Merrill, *Trespass, Nuisance, and the Costs of Determining Property Rights*, 14 J. LEGAL STUD. 13, 26-35 (1985); Henry E. Smith, *Exclusion and Property Rules in the Law of Nuisance*, 90 VA. L. REV. 965, 992-96 (2004).

¹⁶ Wesley Newcomb Hohfeld, *Fundamental Legal Conceptions as Applied in Judicial Reasoning*, 26 YALE L.J. 710 (1917), *reprinted in* WESLEY NEWCOMB HOHFELD, *FUNDAMENTAL LEGAL CONCEPTIONS AS APPLIED IN JUDICIAL REASONING AND OTHER LEGAL ESSAYS* 65-114 (Walter Wheeler Cook, ed. 1923).

This paper argues that property, intellectual property, and organizations all employ modular structures in order to manage complex interactions between economic actors. All three devices break complex systems of interactions between actors into constituent parts, within which interactions are intense but between which interfaces constrain the flow of information. As just noted, the right to exclude in the law of trespass is the most basic and familiar example. As organizational theorists have increasingly emphasized, modularity helps to manage complexity in team production.¹⁷ By specifying interface conditions, a wide range of activities can occur in one module, making the system easier to use, more robust, and more flexible. This paper combines and extends an information-cost theory of property and a modularity-based theory of the firm to explain the property-like aspects of organizations—asset partitioning, legal personality, stability and flexibility over time, team production, and the residual claim—as stemming from modular structures that go beyond the familiar “nexus of-contracts.”

Similarly, intellectual property can achieve information-cost savings through the indirectness and simplicity of basic exclusion rules. Especially with a nonrival resource like information, the right mixture of exclusion, governance, and open access remains an empirical question, but intellectual property, like property and organizational law, can be seen as a second-best solution of a complex coordination problem of attributing outputs to inputs. In this respect, modularity in intellectual property serves a similar function as in property and organizational law.

I. MODULARITY IN PROPERTY LAW

The information-cost theory allows us to draw out a fundamental similarity among property, intellectual property, and organizations. The combination of exclusion and governance strategies in the delineation of property rights results in a modular structure in which limited information permeates the boundaries between the spheres

¹⁷ See, e.g., BALDWIN & CLARK, *supra* note 10; MANAGING IN THE MODULAR AGE, *supra* note 10; Richard N. Langlois, *Modularity in Technology and Organization*, 49 J. ECON. BEHAV. & ORGANIZ. 19 (2002); Ron Sanchez & Joseph T. Mahoney, *Modularity, Flexibility, and Knowledge Management in Product Organization Design*, 17 STRATEGIC MANAGEMENT J. 63 (Special Issue Winter 1996); see also Erich Schanze, *Legalism, Economism, and Professional Attitudes Toward Institutional Design*, 149 J. INSTITUTIONAL & THEORETICAL ECON. 122, 127-38 (1993).

defined by the exclusion rights. Organizations and intellectual property also manage complexity through modularity, and the devices that lend modularity to firms and information production often come from the property element of the law of organizations and intellectual property.

Much of property law can be thought of as specifying the interface conditions between property modules. Thus, the exclusionary strategy sets up basic modules and hides a great deal of information about uses and features of the owner, but we do make exceptions for special problems like airplane overflights, and nuisance law does balance some high stakes use conflicts. These refinements add to the interface and solve problems at the price of less modularity.

Property is the area of law concerned with those rights most based on exclusion. In our terms, this means that property law tends to define rights based on informational variables that that *bunch attributes and uses together* and treats them as a modular component of the legal system. Previously, I have argued that there are two strategies for delineating rights, which I term “exclusion” and “governance,” and that these strategies fall on the poles of a spectrum of methods of informational variables (or, to use the term from neoinstitutional economics, proxy measurement).¹⁸ For example, in the case of land, we use both simple on/off signals like boundary crossings (trespass, some nuisance) and more tailored variables involving the evaluation of conflicting uses (other nuisance law). By distinguishing exclusion and governance based on their different cost structures at different levels of precision, we can explain a wide range of features of property law and its relations to adjacent areas.

The *exclusion* strategy delegates decisions about resource use to an owner who, as gatekeeper, is responsible for deciding on and monitoring how the resource will be used. To set up such rights, informational variables (or proxies) like boundaries and the *ad coelum* rule are used. Crossing the boundary does somewhat correlate with whether a person is imposing costs through use, but only in a very rough sense. Being on the land is necessary to engage in a wide range of such uses, such as picking fruit or parking cars. Those present on the land might or might not be causing harm (and could be causing

¹⁸ Smith, *supra* note 2.

more or less harm), but a rule based on a boundary does not distinguish these cases. In the case of land, the main informational variable relevant to the action of trespass (and much of the law of nuisance) is locational: Has a party invaded the column of space around the land?¹⁹ By having the right to exclude, the owner is protected in a wide range of potential and actual uses, without the law ever having to delineate these use-privileges separately. Indeed, many uses such as using air to blow away chimney smoke are not really rights at all; they are privileges in the owner that are implicitly and indirectly protected by the basic gatekeeper right, the right to exclude.²⁰

The basic structure of property with modular exclusion enriched with an interface of governance rules, can be captured in a simple cost-benefit model.²¹ The key is that different strategies for delineating rights have different cost structures. (We will assume for now that some process or some actor such as an entrepreneur, a judge, etc. will have an incentive to come close to this point, party because such actors are also audiences for rights.) The equilibrium point is where supply and demand intersect, or marginal cost equals marginal benefit. Efforts at delineating, enforcing, and respecting property rights are worthwhile up to the point where an additional unit of such efforts is equal in value to the same as the benefit of extra value wrung from the resource. A graphical version of this model with the cost structures of exclusion and governance can be illustrated as in Figure 1, with Wealth (\$) depicted on the *y*-axis and precision depicted on the *x*-axis:²²

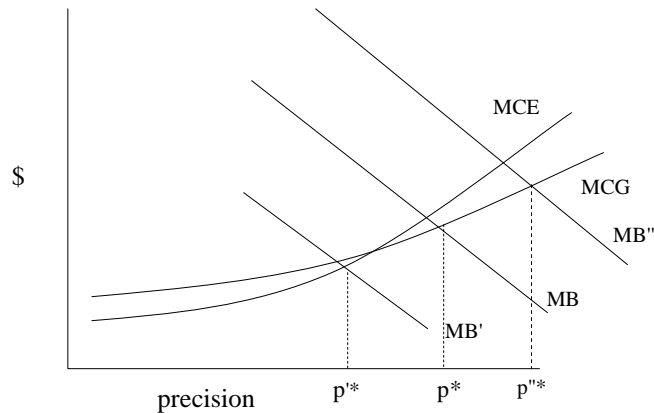
¹⁹ See Smith *supra* note 15.

²⁰ Henry E. Smith, *Self-Help and the Nature of Property*, 1 J.L. ECON. & POL'Y 69 (2005).

²¹ Smith, *supra* note 2, at S474-78.

²² For a discussion of how to operationalize precision, see Smith, *supra* note 18, at S467-79.

Figure 1.—Exclusion and governance for a resource



Again, the cost structures are based on minimal assumptions about the quantities involved. The marginal cost of exclusion (*MCE*) and the marginal cost of governance (*MCG*) differ in shape because of the different proxy measures upon which they rely. Exclusion relies on fences and rough boundaries with on/off signals of violations; this works well as a first cut at defining a resource and preventing the most basic forms of theft by all sorts of pilferers and trespassers. So *MCE* starts out low at low levels of precision, but increases rapidly, because such rough proxies are not suited regulating uses in a finegrained way. Using a fence to regulate levels of noise or odor, much less levels of activity that require access to the parcel, would be prohibitively expensive. As a refinement to the information-hiding modules of exclusion, the governance strategy works the other way around, because it relies on refined with initially high marginal costs. Defining basic trespass rights synthetically based on all the use conflicts involved among the members of society would be prohibitively costly, and highly non-modular. But for more finetuned rights, concerning potential conflicts over noise, odors, or limited-access sheep grazing, eventually the governance strategy is least cost in Figure 1 (*MCG* is the lower of the two marginal cost curves only to the right of the intersection with *MCE*). The envelope of these two cost curves (and the others in between based on variables of intermediate precision) is the “supply” curve formed by selecting, for any given level of

precision (on the x -axis), the lowest of the values of the various marginal cost curves (y) at that x -value. The supply curve is the set of such y -values.²³ As we will see in Part IV, with this model and some knowledge of changes in the size of the costs, we can derive propositions about the direction of changes in property rights.

For low levels of precision, rough informational variables (proxies) like the boundary in the *ad coelum* rule for real property or the chemical structure of a substance for patent law are the cheapest method of delineating rights, but they would be very expensive if employed to pick out individual levels of use. As Robert Ellickson has noted, dogs can be taught to police boundaries but not to detect stealing by those with the privilege of access.²⁴ Similarly, enforcing the right to exclude from a substance or an apparatus is much easier than a right to specific types of uses of these “things.” Generally, exclusion proxies are over- and under-inclusive of the harms caused by individual uses.

The exclusion strategy also has implications for the correlative dutyholders. Exclusion rights are used when the audience (of dutyholders) is large and indefinite (in rem), and the simplicity of exclusion rights reduces the processing costs which would be high for such extensive audiences.²⁵ Recall the examples of the anonymously parked cars. When large numbers can contribute to the value of the resource by keeping off, rough informational variables of exclusion will be used to send this simple message.

If exclusion bunches uses together, the *governance* strategy, by contrast, picks out uses and users in more detail, imposing a more intense informational burden on a smaller audience of dutyholders.²⁶ For example, a group of herdsman have rights to graze animals, but the rights among themselves may be limited to a certain number of animals, time of grazing, and so on. In the case of land, if governance rules are those that pick out more specific activities for measurement, then a wide range of rules—from contractual

²³ See Smith, *supra* note 2, at S476-77.

²⁴ Robert C. Ellickson, *Property in Land*, 102 YALE L.J. 1315, 1327-28 (1993).

²⁵ See Smith, *supra* note 18, at S468-69; Henry E. Smith, *The Language of Property: Form, Context, and Audience*, 55 STAN. L. REV. 1105, 1151-53 (2003).

²⁶ See Smith, *supra* note 18, at S455, S468, S471-74.

provisions, to norms of proper use, to nuisance law and public environmental regulation—can be seen as reflecting the governance strategy.

Sometimes, use on multiple scales becomes important enough to allow for overlapping modules in which some attribute is subject to multiple property modules. A semicommons exists where private and common property regimes overlap physically and the two regimes interact: a semicommons must tolerate or address the strategic behavior made possible by the enhanced access from the overlap.²⁷ In the medieval and early modern open fields, strategic behavior of favoring one's own parcel with manure and harming others' parcels with excessive trampling of sheep was only possible through the access afforded by throwing the entire set of privately owned strips open as a grazing common during fallow periods and right after harvest.²⁸ I have argued that enforcing a pattern of scattered narrow strips made the picking and choosing necessary to engage in this type of strategic behavior prohibitively costly, and thereby served as a governance mechanism.²⁹ This semicommons type of overlap is particularly likely in intellectual property, because access to information is more difficult to prevent and presumptively undesirable from its nonrival character.³⁰ Doctrines like fair use in copyright can be regarded as an overlap between private rights and the public domain, and as a very complicated interface between the two.

²⁷ Henry E. Smith, *Semicommon Property Rights and Scattering in the Open Fields*, 29 J. LEGAL STUD. 131, 131-32, 138-42 (2000).

²⁸ *Id.* at 134-38, 144-54.

²⁹ *Id.* at 144-54.

³⁰ See, e.g., Brett M. Frischmann, *Evaluating the Demsetzian Trend in Copyright Law*, 3 REV. L. & ECON. 649, 651 (2007); Robert A. Heverly, *The Information Semicommons*, 18 BERKELEY TECH. L.J. 1127 (2003); Lydia Pallas Loren, *Building a Reliable Semicommons of Creative Works: Enforcement of Creative Commons Licenses and Limited Abandonment of Copyright*, 14 GEO. MASON L. REV. 271 (2007); Peter K. Yu, *Intellectual Property and the Information Ecosystem*, 2005 MICH. ST. L. REV. 1, 11-12; see also, e.g., Ellen P. Goodman, *Spectrum Rights in the Telecosm to Come*, 41 SAN DIEGO L. REV. 269, 379-403 (2004); Henry E. Smith, *Governing the Tele-Semicommons*, 22 YALE J. ON REG. 289 (2005). Like tangible property rights, IP rights are not absolute. Michael A. Carrier, *Cabining Intellectual Property through a Property Paradigm*, 54 DUKE L.J. 1 (2004).

II. MODULAR PROPERTY IN ORGANIZATIONS

Organizations serve as a method of coordinating interaction, but the same can be said of contracts. What, if anything, makes corporations more than a set of contracts, or even lends them the character of property? In this Part, I isolate the common element in a number of theories of the firm that see in firms something more than a collection of contractual relations, and argue that these aspects all flow in part from the modularity of the property element in organizational law.

One might doubt that a corporation or other business firm is more than a collection of contracts. The dominant paradigm in corporate law is the nexus of contracts.³¹ Corporations are a collection of contracts between various subsets of shareholders, managers, creditors, employees, and customers, and these relations are rife with agency costs. In a zero-transaction-cost world, the transactions between these various actors would be costless, and it would not matter whether the transaction took place in a firm or on the market or in some other form.³² As Coase pointed out, one puzzle is why there are firms (or markets) and why the boundary of the firm is where it is (make or buy). Coase's answer was to develop the idea that market transactions and control relations in the firm have different costs and benefits under varying conditions. Thus the development of the telephone might lower the cost of firm-internal control more than it lowers the cost of transacting on the open market, and the boundary of the firm would shift outward to embrace more economic activity.³³

Others have emphasized the different exposure to opportunism in market versus firm-internal transactions. Firms protect parties vulnerable to opportunism and hold-up in particular.³⁴ For example, if parties are contracting over a transaction-specific asset

³¹ See, e.g., FRANK H. EASTERBROOK & DANIEL R. FISCHER, *THE ECONOMIC STRUCTURE OF CORPORATE LAW* 171-73 (1991); Michael C. Jensen & William H. Meckling, *Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure*, 3 J. FIN. ECON. 305, 311 (1976).

³² Ronald H. Coase, *The Nature of the Firm*, 4 *ECONOMICA* 386 (1937).

³³ *Id.* at 397 n.3.

³⁴ See, e.g., OLIVER WILLIAMSON, *THE ECONOMIC INSTITUTIONS OF CAPITALISM* 68-72 (1985); OLIVER WILLIAMSON, *THE MECHANISMS OF GOVERNANCE* 93 (1996); Benjamin Klein, Robert G. Crawford & Armen A. Alchian, *Vertical Integration, Appropriable Rents, and the Competitive Contracting Process*, 21 J.L. & ECON. 297 (1978).

with quasi-rents, the asset would be much less valuable in another transaction.

Contracting to prevent opportunism against the investing party may be so costly that it makes sense to place control over the asset with the firm and direct its use through a manager's authority rather than with a more elaborate contract.³⁵

Others still treat corporations and other business forms as little more than defaults.³⁶ Firms really are a collection of contracts and there is little that is special about firms. On this view, problems like communication or opportunism are not different in kind from the problems that ordinary contracts solve. The only difference in the case of business associations is that the problems are well-known and amenable to an off-the-rack default regime. If so, then one would expect that corporate law will not be mandatory. Any seemingly mandatory features would be normatively problematic.

Recently some organizational theorists have discovered the role of modular structures in managing the complexity of interactions.³⁷ The benefits of modularity are familiar from the development of computer software and hardware. A crucial turning point in software development was one early experiment with a nonmodular process; on one famous project within six weeks the central log grew to be five feet thick, and growing at 150 interfiled pages a day.³⁸ More recently object-oriented programming takes major advantage of modularity.³⁹ Organizational theorists are building on the role of modularity in design teams in the computer industry to explore the benefits of modularity in business organizations more generally.⁴⁰

³⁵ See, e.g., OLIVER HART, FIRMS, CONTRACTS, AND FINANCIAL STRUCTURE (1995); Sanford J. Grossman & Oliver D. Hart, *The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration*, 94 J. POL. ECON. 691, 694 (1986); Oliver Hart & John Moore, *Property Rights and the Nature of the Firm*, 98 J. POL. ECON. 1119 (1990).

³⁶ See, e.g., Frank H. Easterbrook & Daniel R. Fischel, *The Corporate Contract*, 89 COLUM. L. REV. 1416 (1989).

³⁷ See *supra* note 17.

³⁸ FREDERICK P. BROOKS, *THE MYTHICAL MAN-MONTH: ESSAYS ON SOFTWARE ENGINEERING* 76 (1975).

³⁹ See, e.g., GRADY BOOCH, *OBJECT-ORIENTED ANALYSIS AND DESIGN* (2d ed. 1994); EDWARD YOURDON, *OBJECT-ORIENTED SYSTEMS DESIGN: AN INTEGRATED APPROACH* (1994).

⁴⁰ See the sources cited in note 17 *supra*.

This branch of the organizational literature starts from the role of modularity in dealing with complexity in systems. The set of actors and transactions that might be located within or outside the firm form a complex system characterized by numerous internal interactions or interdependencies, making it difficult to infer the properties of the whole system from the parts and their modes of interaction.⁴¹ Modularity involves information hiding, which allows encapsulated components to interconnect only in certain ways. Firms both hide information from the outside and exhibit modular internal structure. Both types of modularity allow work to go on in parallel and facilitates certain kinds of innovation and evolution for a simple reason: adjustment can happen within modules without causing major ripple effects. This ability to experiment increases option value.⁴² Human minds can understand the system as a whole better than a less modular system, and modularization can facilitate specialization, in that work on subparts of the system can proceed in partial ignorance of what is going on with other modules. Only the most radical changes require a remodularization.

The problem of organizing research and development and its commercialization can also benefit from modular structures. Sometimes the structure of a problem will come pre-modularized, thereby obviating the need for elaborate organizational structures or property rights. Tasks like proofreading, checking certain NASA data, or components of some software are easily modularized at a very fine grain.⁴³ Thus in some cases, problems are structured in such a way that people can with minimal coordinating efforts work collaboratively.⁴⁴

⁴¹ SIMON, *supra* note 9, at 195.

⁴² BALDWIN & CLARK, *supra* note 10; Kim B. Clark & Carliss Y. Baldwin, *The Option Value of Modularity in Design: An Example from Design Rules*, Volume 1: *The Power of Modularity* (Harvard NOM Working Paper No. 02-13; Harvard Business School Working Paper No. 02-078, Jan. 2009).

⁴³ See Yochai Benkler, *Sharing Nicely: On Shareable Goods and the Emergence of Sharing as a Modality of Economic Production*, 114 YALE L.J. 273, 281-305 (2004).

⁴⁴ See Carol Rose, *The Comedy of the Commons: Custom, Commerce, and Inherently Public Property*, 53 U. CHI. L. REV. 711 (1986), or in more specialized contexts of modular tasks such as those involved in open-source software, to produce one, *see, e.g.*, Yochai Benkler, *Coase's Penguin, Or, Linux And The Nature of The Firm*, 112 YALE L.J. 369 (2002); Greg R. Vetter, *The Collaborative Integrity of Open-Source Software*, 2004 UTAH L. REV. 563.

Sometimes, problems and interactions need to be structured to take advantage of modularity. Exclusion works best where legal structures can break a system into mid-sized modules: within the module interaction may be coordinated by an owner (private property, corporations) or decentralized among many owners (common property, partnerships), but the information about these interactions is hidden from the outside. If a collection of attributes is highly complementary and subject to interactive and uncertain use, this is a reason to segregate them into a property module rather than to create smaller modules for each attribute. How lumpy, or exclusion-like, the modules should be is an empirical question, as is how many problems are like the subset of software that is suited to open source. Many situations appear to require some type of coordination through a firm or market. Again, the level of disaggregation into modules and the degree to which internally they should come under the central control of one or more actors are empirical questions.

Nevertheless, business associations do seem to have some mandatory features, and the nexus of contracts seems to be more than the collection of contracts that it is made up of. If so, contractual theories of the firm need a theory of the nexus. Why is a nexus of contracts or special firm-like contract necessary as opposed to plain old contracts? In the sections that follow I will show how some proposed answers fit into a modular theory of property. The relative costs of transactions, whether for technological or opportunistic reasons might be aspects of this nexus. Others have proposed asset partitioning, i.e. the protection of firm assets from the owners' creditors and the protection of the owners from the firm's creditors. Some point to legal personality as a feature of firms that collections of contacts do not have. Others point to residual claimancy as the defining feature of a firm.

What I will claim here is that *all* of these special features of firms have something in common: the modularity afforded by their property aspect. Indeed, organizations can be thought of as "entity" property.⁴⁵ Organizations are modular in that interactions may be intense within the organization but this information is largely hidden to those outside. Interface conditions specify what information is relevant to the outside. Consider some

⁴⁵ THOMAS W. MERRILL & HENRY E. SMITH, PROPERTY: PRINCIPLES AND POLICIES 680-81 (2007).

of the special aspects of business organizations that are difficult to capture by private contracting.

1. Asset Partitioning. Various business organizations define pools of assets and determine the access or lack of access of classes of creditors to those pools. Hansmann and Kraakman have called this “asset partitioning.”⁴⁶ Familiar limited liability (for example, for corporate shareholders) is a form of what they call “defensive asset partitioning”: the firm’s creditors cannot come after the non-firm assets of the firm’s owners. By contrast, affirmative asset partitioning protects the firm’s assets from the owner’s creditors: this important feature is often taken for granted but it would be virtually impossible to replicate this solely through contract law.⁴⁷ The transaction costs of entering into and enforcing all the negative covenants would be prohibitive. This makes affirmative asset partition both property-like and an essential contribution to organization law that goes beyond contract.⁴⁸

Consider an example of Firm A, which makes computer hardware and Firm B, a grocery chain, as illustrated in Figure 2. The boundaries around Firm A and Firm B create a modular structure. Firm A has several interfaces: it is owned by Owner 1 and Owner 2, and it has one creditor. In addition it interacts with other actors, contractual partners, tort victims, etc. Because of defensive asset partitioning, neither the creditor nor these other actors can reach Owner 1 and his assets—only *his* creditor can. Affirmative asset partitioning means that Owner 1’s creditor cannot reach the firm’s assets—or those of the other actors for that matter. Nor can the creditors of Firm B, the grocery chain, reach the assets of Firm A, either directly or indirectly through Owner 1. Owner 2, who owns a share of Firm A but not Firm B, need not worry at all about the risks and activities of Firm B at all. Owners (like Owner 2) and Firm A’s creditor can specialize in monitoring a computer hardware business and need not know anything about groceries. More generally, what goes on in Firm A is not relevant for Firm B and vice versa. As we will see, not only are they separate from the point of view of creditor-

⁴⁶ Henry Hansmann & Reinier Kraakman, *The Essential Role of Organizational Law*, 110 YALE L.J. 387, 393-94 (2000).

⁴⁷ *Id.* at 398.

⁴⁸ *Id.*

debtor relations, but all sorts of other decisions and requirements that apply to the one Firm will have no bearing on the other Firm and the actors whose interface is with it—unlike the case where the assets of the two firms were in one large firm.

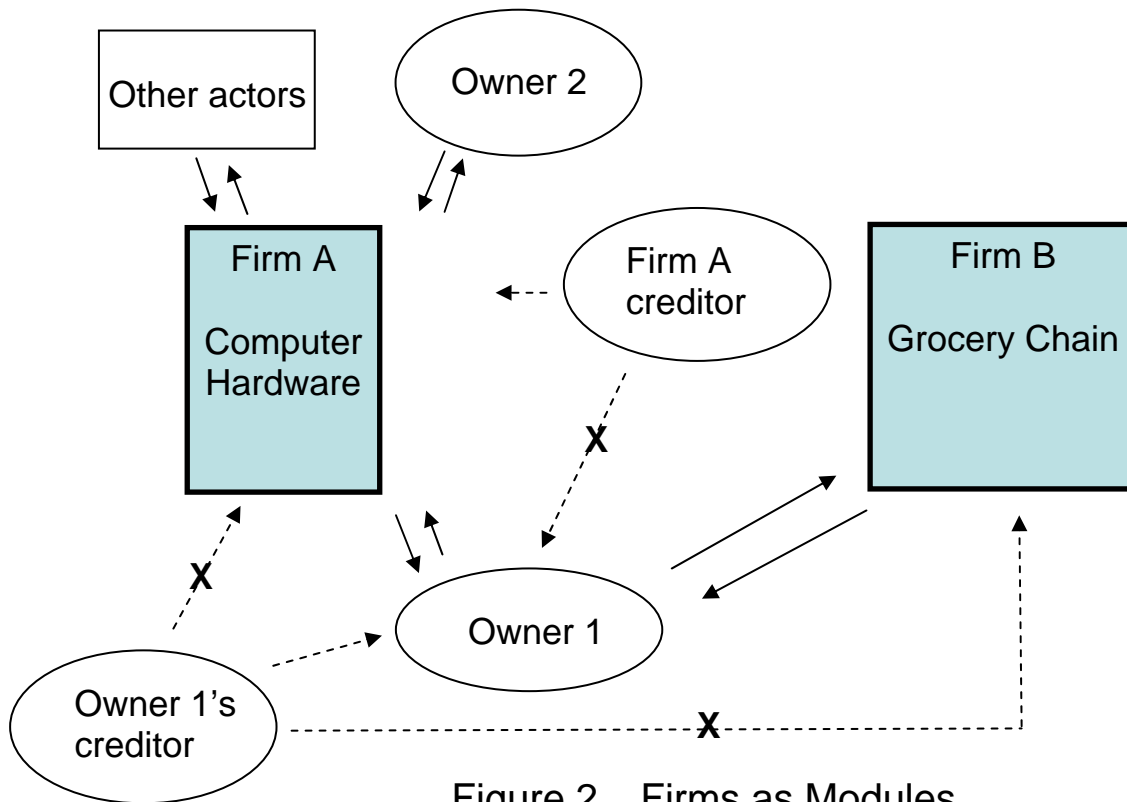


Figure 2 – Firms as Modules

In sum, asset partitioning, like property, is also modular. Asset partitioning means that information about the firm owner's credit situation is irrelevant to the creditors of the firm and information about the firm's creditors is of limited relevance to the firm owner's creditors. Information is blocked across modules and this allows economization on information and the substitution of structures without massive ripple effects.

2. Legal Personality and in Rem Effect. Another feature of firms whose economic significance is often overlooked is legal personality. Iacobucci and Triantis point out that only firms can be owners; subparts of firms such as divisions cannot contract on their own, own property, sue or be sued.⁴⁹

⁴⁹ Edward M. Iacobucci & George G. Triantis, *Economic and Legal Boundaries of Firms*, 93 VA. L. REV. 515 (2007).

To be sure, a firm can have internal modular structure, and even from a capital structure point of view some firms have made attempts to use this internal structure, most notably in security interests on the debt side and tracking stock on the equity side. Iacobucci and Triantis note that the only way to achieve separate capital structure for a proper subset of a firm's assets would be nonrecourse secured debt, but they point out that the law sometimes treats nonrecourse debt as if it were recourse, especially in bankruptcy, thus defeating the internal modular debt structure. To the extent that security interests do allow for true asset partitioning, they require a property-like simplicity in the interests of notice to third parties, which is what we find.⁵⁰ A firm boundary certainly does achieve the effect of asset partitioning, as long as the firms are truly distinct (as opposed to an undercapitalized subsidiary, for example). On the equity side, achieving internal modular structure is even more difficult. Tracking stock does not give a right on dissolution to a specific pool of assets; instead it typically gives a share in the firms as a whole.

As a result, the capital structure of firms in more than one business needs to be a blend of the structures that would be ideal for the businesses standing alone. Aspects of the firm would be different if assets were in two firms. Nontransparent assets call more for private debt and closely held equity, than assets that are easy to value and monitor.⁵¹ A risky growth opportunity will be funded more by equity, etc. But one cannot tailor the mix of equity and debt to different assets in different businesses without creating separate firms. Further aspects of firms for which the features of assets are relevant—like takeover defenses and the composition of a board—must be tied to the firm as a whole, not to divisions or other pools of assets. Firms can have modular internal structure for many purposes, especially for the substantive purposes of decisionmaking and production: in a hypothetical firm that embraces all of the assets of Firms A and B above, the computer chip R&D and the production line will operate wholly independently of most aspects of the grocery business.

⁵⁰ Thomas W. Merrill & Henry E. Smith, *The Property/Contract Interface*, 101 COLUM. L. REV. 773, 833-43 (2001).

⁵¹ Triantis & Iacobucci, *supra* note 49, at 519-20.

The flip side of the difficulty of creating tailored capital structures within firms is that the modules furnished by organization law present lower information costs for outsiders. The lack of free customization of capital structure to pools of assets without creating a firm-boundary around them may increase the ease of monitoring, and it allows only certain types of information about ownership and structure to be relevant to the outside world. Idiosyncratic finegrained information is not allowed. As with standardization in general there is some loss: as Iacobucci and Triantis point out, to the extent that putting different asset pools in separate firms prevents true economic integration, the benefits of that integration are foregone. They argue that contracting among related firms suffers from higher transaction costs that and legal requirements may make even wholly owned subsidiaries less economically integrated than a division. However severe this problem is in practice, there may be standardization benefits as well.

Returning to Figure 2, in general, the firm boundary is a signal for the asset partitioning and other capital structure division under discussion here. When one encounters a firm boundary one knows that certain capital structure issues have been decided with respect to that pool of assets and all the assets that pool contains. This may have benefits for third parties. Armour and Whincop show how the rules of corporate law prevent firm-internal information from overly impacting third parties through a combination of standardization (*numerus clausus*),⁵² registries, and protection of third parties from liability that would otherwise follow from notice of the firm-internal information.⁵³ Generally, firms like property itself use mandatory rules to encapsulate information in their modules and to prevent some information from impacting third parties external to the module. Finally, basic issues like legal personality (including the capacity to contract, to own property and to sue and be sued) are true not just of the firms in Figure 2 but all the actors (most obviously the case with natural persons). There is a standard interface for the interaction of “persons” in general, as defined by the legal

⁵² Thomas W. Merrill & Henry E. Smith, *Optimal Standardization in the Law of Property: The Numerus Clausus Principle*, 110 YALE L.J. 1 (2000).

⁵³ John Armour & Michael J. Whincop, *The Proprietary Foundations of Corporate Law*, 27 OXFORD J. LEGAL STUD. 429 (2007).

system. The consequences of contracts, torts, etc., by one actor with respect to another are predictable because of this carving up of the world into legal actors.

3. The Problem of the Future. Property faces the problem of durability. Property rights tend to last longer than contract rights.⁵⁴ Circumstances may change over these long periods, making today's structure less suited to the changed circumstances of the future. One solution from property law is to supply changes to the basic set-up off the rack. Organizational law allows for this as well: by opting into a form like the corporation, one is opting into future changes the legislature may make to the form.⁵⁵ In a sense, some of the changes in the module can be treated themselves as informationally encapsulated. This function of property and organizational law is largely a matter of default but it is a function that would be very difficult to replicate purely by contract. The inability of normal contracts to capture the flexibility of a semi-stable form like a corporation or the fee simple is one of the rationales for the forms themselves.⁵⁶

4. Team Production. Among economists the structure of organizations has been studied in detail with a view to explaining why we have organizations at all in addition to market contracting.⁵⁷ Some theorists locate the basic reason for having both organizations and markets in a certain type of information cost—the problem of metering.⁵⁸ Consider outputs like grain or cars. Where the output is relatively easy to measure, these outputs will be traded in markets. But where inputs are easier to measure than outputs, the transaction is likely to occur within a firm. This is particularly true where the organization is engaged in *team production*, in which the contributions of the

⁵⁴ See, e.g., Carol M. Rose, *What Government Can Do for Property (and Vice Versa)*, in THE FUNDAMENTAL INTERRELATIONSHIPS BETWEEN GOVERNMENT AND PROPERTY 214-15 (Nicholas Mercuro & Warren J. Samuels eds. 1999); see also Glen O. Robinson, *Explaining Contingent Rights: The Puzzle of "Obsolete" Covenants*, 91 COLUM. L. REV. 546, 572-79 (1991); Molly Shaffer Van Houweling, *The New Servitudes*, 96 GEO. L.J. 885 (2008).

⁵⁵ See Henry Hansmann, *Corporation and Contract*, 8 AM. L. & ECON. REV. 1 (2006).

⁵⁶ And contracts that purport to be totally inflexible in the face of the future sometimes meet with judicial skepticism; when and where this skepticism is warranted is beyond the scope of this paper.

⁵⁷ The starting point for this literature is R.H. Coase, *The Nature of the Firm*, 4 *Economica* (n.s.) 386 (1937).

⁵⁸ Armen A. Alchian & Harold Demsetz, *Production, Information Costs, and Economic Organization*, 62 AM. ECON. REV. 777 (1972).

inputs to make the output are complex and synergistic rather than additive. If two people are moving a piano, a relatively simple example of team production, the effort of each increases the productivity of the other and it is hard solely by observing total output to attribute portions of the output to each input.⁵⁹

But if the reason for firms is the metering costs of inputs versus outputs, the costs of metering both inputs and outputs will vary depending on the proxies used to measure them.⁶⁰ Thus, in a firm one can pay by the hour or by certain subtasks. Coarse measures of inputs are cheaper and may be more cost-effective than more precise ones even if there is some evasion. For example, if a sales force is on a commission system, it may be cheapest to assign exclusive territories in order to monitor output (roughly) even though to the overall enterprise it makes no difference who makes any particular sale; but the territories may be cheaper than tracking individual sales effort and other inputs and activities.⁶¹ Another problem is that if the task is multidimensional, too high-powered incentives can lead to inefficient substitution away from more unrewarded margins; this too points towards coarser measures.⁶² The same is true on the output side, and, as we will see, this is where intellectual property is most like property. Team production and the complementarity of resource attributes (and the actions people take to use or enhance them) present a complex problem, and one method used in both organizations and, I argue, property is to employ modular structures.

5. Residual Claimancy. Another reason firms are like property in their modularity centers on the notion of residual claimancy. In the “nexus of contracts” that is the firm, these contracts are not all specified contract by contract but make reference to firm boundaries. In particular the delineation of the residual claim can be economized on because it relies on the “outer boundary” of the firm and its value. The residual is

⁵⁹ *Id.* at 779.

⁶⁰ Yoram Barzel, *Measurement Cost and the Organization of Markets*, 25 J.L. & ECON. 27, 28 & n.3 (1982).

⁶¹ See, e.g., Richard A. Posner, *Antitrust Policy and the Supreme Court: An Analysis of the Restricted Distribution, Horizontal Merger, and Potential Competition Decisions*, 75 COLUM. L. REV. 282, 292-93 (1975); Richard A. Posner, *The Next Step in the Antitrust Treatment of Restricted Distribution: Per Se Legality*, 48 U. CHI. L. REV. 6, 6 (1981).

⁶² Bengt Holmstrom & Paul Milgrom, *Multi-Task Principal-Agent Analyses: Incentive Contracts, Asset Ownership, and Job Design*, 7 J.L. ECON. & ORG. 24 (Special Issue 1991).

everything owned by the firm after all lesser interests (separately delineated) have been paid off).⁶³

Interestingly, various theories see the residual claim as a method of lowering information costs. For example, Barzel theorizes that entrepreneurs receive the residual claim because their contribution is the hardest to measure.⁶⁴ By first measuring by contract the contribution of other inputs, the residual claim need only be defined as the outer boundary of the collection of assets minus these claims. Likewise, capital contributions are difficult to measure and if one used detailed proxies to measure the contribution of capital it would be subject to appropriation in hard to detect ways.⁶⁵ These factors likewise are rationales for locating the residual claim with the contribution of capital.

Likewise, a residual claimant has incentives to monitor.⁶⁶ Recently a debate has arisen over whether managers should maximize shareholder value (subject to contractual duties to other actors) or should owe duties to other stakeholders as well.⁶⁷ One argument is that duties to multiple, heterogeneous stakeholders gives managers too many masters and a duty to all of them is too difficult to evaluate, thereby weakening the set of duties overall.⁶⁸ Ultimately this is an empirical question, involving too the ability of other

⁶³ Alchian & Demsetz, *supra* note 58, at 781-83; Yoram Barzel, *The Entrepreneur's Reward for Self-Policing*, 25 *ECON. INQUIRY* 103 (1987).

⁶⁴ *Id.*

⁶⁵ See, e.g., Oliver Williamson, *Corporate Governance*, 93 *YALE L.J.* 1197, 1210 (1984).

⁶⁶ See, e.g., Eugene F. Fama & Michael C. Jensen, *Agency Problems and Residual Claims*, 26 *J.L. & ECON.* 327 (1983).

⁶⁷ See, e.g., Margaret M. Blair & Lynn A. Stout, *A Team Production Theory of Corporate Law*, 85 *VA. L. REV.* 248 (1999); Margaret M. Blair & Lynn A. Stout, *Corporate Accountability: Director Accountability and the Mediating Role of the Corporate Board*, 79 *WASH. U.L.Q.* 403 (2001); but see, e.g., Mark E. Van Der Weide, *Against Fiduciary Duties to Corporate Stakeholders*, 21 *DEL. J. CORP. L.* 27 (1996); JOSEPH F. JOHNSTON, *NO MAN CAN SERVE TWO MASTERS: SHAREHOLDERS VERSUS STAKEHOLDERS IN THE GOVERNANCE OF COMPANIES* (1998); see also Jonathan R. Macey, *Fiduciary Duties as Residual Claims: Obligations to Nonshareholder Constituencies From A Theory of the Firm Perspective*, 84 *CORNELL L. REV.* 1266 (1999).

⁶⁸ ROBERT CLARK, *CORPORATE LAW* 20 (1986); but see Jonathan R. Macey, *An Economic Analysis of the Various Rationales for Making Shareholders the Exclusive Beneficiaries of Corporate Fiduciary Duties*, 21 *STETSON L. REV.* 23, 33 (1991) (arguing that "too many masters" argument is overstated because of complex share structures whose holders can have conflicting interests).

constituencies to protect themselves through contract, but the specialization of monitoring by the residual claimant partakes of the advantages of modularity.

III. EXCLUSION IN INTELLECTUAL PROPERTY

Exclusion furnishes modular structures to intellectual property, as I have argued elsewhere.⁶⁹ Exclusion is particularly controversial in intellectual property because of the nonrivalness of information.⁷⁰ Exclusion from information imposes a loss because the information could be enjoyed costlessly by additional consumers.⁷¹ Traditionally intellectual property has been justified by the incentives to create it affords. In this section I will suggest that exclusion serves to create modular structures that form the basis for a system of appropriating the returns from rival resources, like labor and lab space, to the development of information, especially its commercialization. How strong and what type of modules are needed remain empirical questions, but the function of the exclusion strategy in affording modularity to the coordination of inputs to commercialization is easily overlooked.

Like other property, intellectual property rights provide simple ground rules and a platform for further contracting and forming organizations.⁷² Officials and dutyholders need not know much unless they choose to contract with the holder of the rights. Consider how much information is hidden behind the boundaries of an intellectual

⁶⁹ Henry E. Smith, *Intellectual Property as Property: Delineating Entitlements in Information*, 116 YALE L.J. 1742 (2007).

⁷⁰ See, e.g., JAMES BOYLE, SHAMANS, SOFTWARE, AND SPLEENS: LAW AND THE CONSTRUCTION OF THE INFORMATION SOCIETY 38 (1996); Yochai Benkler, *Free as the Air to Common Use: First Amendment Constraints on Enclosure of the Public Domain*, 74 N.Y.U. L. REV. 354, 420-21 (1999) (using the fence analogy, and arguing against information enclosure); Julie E. Cohen, *Lochner in Cyberspace: The New Economic Orthodoxy of "Rights Management"*, 97 MICH. L. REV. 462 (1998).

⁷¹ The conventional view is that competition will drive prices down to this zero (or low) marginal price, without allowing the fixed costs of creation to be covered. Chris Yoo has argued that in keeping with the "Samuelson condition" for public goods, the problem is that the good enters into multiple people's utility functions and they each have an incentive to misrepresent their demand. Christopher S. Yoo, *Copyright and Public Good Economics: A Misunderstood Relation*, 155 U. PA. L. REV. 635 (2007).

⁷² One of the roles of property rights is to serve as a platform for further contracting. For an exploration of this in connection with precontractual liability and enforcement flexibility, see Robert P. Merges, *A Transactional View of Property Rights*, 20 BERKELEY TECH. L.J. 1477 (2005).

property right. As with other assets, someone must decide which combination of uses of the rival inputs to developing the information is best. The number of combinations is $n!/((n-r)!r!)$ for a set of n uses taken r at a time, but we may not know *ex ante* which uses are compatible with which. If some uses are compatible only in certain sequences (in the case of land this might be graingrowing and then hunting but not vice versa) then the number of permutations (ordered combinations) is even greater, i.e., $n!/(n-r)!$. With intellectual property rights that delegate to owners the development of information about uses and the choice among them, outsiders (officials and dutyholders) need not know the exact makeup of the set; all officials and dutyholder need to know are the “interface” conditions of when a violation of the right has occurred (as by crossing a boundary or practicing a patented invention).⁷³ Through use or subsequent transfer, the owner enjoys the fruits or the loss that flows from these complex choices.

The indirectness of the right to exclude and the interests in uses that it protects is also characteristic of intellectual property. With a right to exclude from a wide and indefinite range of uses, the intellectual property owner can take a correspondingly wide range of actions and appropriate the returns (positive or negative) from these efforts without outsiders—potential violators, officials, and to some extent contractual partners—needing to know much about these uses. In the case of patent law this is whether someone not licensed by the patentee is making, using, or selling the invention.⁷⁴ If the uses delegated in this way were all *nonrival* with the uses that might be prevented under the right to exclude, the case *against* intellectual property could not be clearer. However, the inputs to these uses—the labor, equipment, etc.—needed to develop the

⁷³ For the role of delegation to owners in an information-cost theory of property, see, e.g., Smith, *supra* note 15, at 1021-45.

⁷⁴ Patent Act, 35 U.S.C. § 271; *Bloomer v. McQuewan*, 55 U.S. (14 How.) 539 (1852) (noting that “[t]he franchise which the patent grants, consists altogether in the right to exclude every one from making, using, or vending the thing patented, without the permission of the patentee. This is all he obtains by the patent;” and noting that right to use a machine is not within the scope and is governed by state property law”). See also Craig Allen Nard, *Certainty, Fence Building, and the Useful Arts*, 74 IND. L.J. 759, 759 (1999) (“Patent law is about building fences.”), citing CENTENNIAL PROCEEDINGS OF THE UNITED STATES PATENT SYSTEM 1891, at 43, 51 (Executive Comm. of the Patent Centennial Celebration ed., 1990) (Commissioner of Patents writing in the late 19th century that claims are important as “set[ting] definite walls and fences about the rights of the patentee”). Adam Mossoff has argued that the mainstream nineteenth century view of patents was not as focused solely on the right to exclude and that rights of exclusive use were considered foundational. Adam Mossoff, *Exclusion and Exclusive Use in Patent Law*, 22 HARV. J.L. & TECH. 321 (2009).

information *are* rival. The use of these and the return from them is swept along indirectly in the right to exclude.

Further, those who in a world of zero transaction costs might contract with commercializing “input” providers can do so while focusing their attention on low-cost, narrow, and indirect proxies instead.⁷⁵ For example, in joint ventures, allocating inputs and outputs presents a severe measurement problem. Intellectual property rights allow for precontractual liability and flexible enforcement.⁷⁶ As modular structures, the simple proxies for finding a violation can be used as a reference point in contracting over these inputs and outputs. Likewise, because the proxy is especially simple in patent law in the sense that independent invention is not a defense to liability, the law of employee inventions and further contracting with employees is made simpler.⁷⁷ If independent invention were a defense, each side could more easily threaten to defect from the deal. Again, in general, intellectual property serves an asset partitioning function,⁷⁸ and modularity theory allows us to see how general this function is.

Whether it would be better to separately value each input (and trace through its contribution to the overall return on the informational asset) is an empirical question, first raised in the context of firms but applicable to the question of intellectual property. On the benefit side, unlimited tracing of this sort would allow unimpeded use of the informational asset, in accordance with its nonrival nature for consumers. On the cost side, the tracing would be far costlier than lumping these “uses” in within the functional scope of the exclusion right: by exercising the right to exclude, the interest in using these more causally “remote” rival inputs and appropriating their return comes along automatically—without a separate need to delineate or even identify these uses and inputs by any third party. In regular property the right to exclude indirectly protects use

⁷⁵ Paul Heald develops the similarity between patent law and the asset partitioning function of organizational law. See Paul J. Heald, *A Transaction Costs Theory of Patent Law*, 66 OHIO ST. L.J. 473 (2005).

⁷⁶ See Merges, *supra* note 72, at 1479.

⁷⁷ Robert P. Merges, *The Law and Economics of Employee Inventions*, 13 HARV. J.L. & TECH. 1, 21 & n.69 (1999) (recognizing a greater emphasis on teamwork and cooperative tasks in patent law).

⁷⁸ Heald, *supra* note 75, at 480-84.

privileges, but because positive transaction costs prevent some contracts, the exclusion right will prevent some beneficial, nonharmful—and in that sense nonrival—uses. The analogous rights in intellectual property likewise benefit from their indirectness but at the price of foregone use.⁷⁹ The right to exclude is both the greatest strength and weakness of intellectual property rights—as it is in regular property. The difference between property and intellectual property in this respect looks like a matter of degree rather than of kind.

Indirect evidence suggests that the modularity of the intellectual property system may be one of its greatest strengths. Organizational forms dealing with the design and production of technologically innovative products (computer hardware and software being prime examples) and innovative artifacts tend to be modular. In these situations, those creating the organization face most of the costs and benefits of the organizational form. Although firms and markets are different, intellectual property facilitates organizational efforts—involving development and commercialization of innovation and accompanying appropriability—outside of the corporation or other business organizations. Intellectual property may serve a similar coordinating function in a similarly modular way.

As in property law, intellectual property employs the governance strategy to finetune the basic exclusionary regime by further specifying the interface between property modules. Within intellectual property, the patent law relies heavily on the right to exclude. For example, in a chemical invention, the applicant can claim a substance by stating its structure.⁸⁰ Any use of the substance, whether foreseen by the applicant at the time of the application or not, is protected by this right to exclude. The right to exclude others from using the substance bunches together a wide range of uses that the law need never specify individually. The law delegates to the patentee the choice among these uses. As a result, there is a wide range of activities that the patentee can take to promote the invention, including further development not resulting in improvement patents, advertising, marketing, etc., the returns of which the patentee will be able to capture.

⁷⁹ Henry E. Smith, *Institutions and Indirectness in Intellectual Property*, 157 U. PA. L. REV. 2083 (2009).

⁸⁰ See, e.g., *In re Thuau*, 135 F.2d 344, 347 (C.C.P.A. 1943) (“[A] patentee is entitled to every use of which his invention is susceptible, whether such use be known or unknown to him.”).

Under certain circumstances, the patentee can also use the *functionally broad* right to exclude in its efforts to coordinate further innovation.⁸¹

Patent law does contain governance rules as well. With the patented chemical invention, the law provides a very narrow use-based exception for experimental use,⁸² the exception focuses on the type of use and requires detailed evaluation of the experimental user's motivations. (For example, these days commercial motivation will usually disqualify a use as experimental.⁸³) As another example, the law of patent misuse—as its name suggests—singles out particular uses that are thought to extend the patent beyond its lawful scope and withdraws enforceability from the patent.⁸⁴

Copyright makes even greater use of governance rules than does patent law. In copyright, the rights themselves tend to be built up more stick by stick than in patent law, and modifications, most prominently the fair use doctrine, focus in on particular types of uses. In addition to these rules supplied by the law as a package—off-the-rack rules—a governance regime might emerge privately through licensing: another party might be

⁸¹ Perhaps because of the emphasis in the reward theory on innovation rather than (nonpatentable) commercialization, critics of Kitch's prospect theory, see Edmund W. Kitch, *The Nature and Function of the Patent System*, 20 J.L. & ECON. 265 (1977), have focused on the difficulties that patentees will have in coordinating further innovation where others can get improvement patents, leading to a situation of blocking patents. See, e.g., Mark A. Lemley, *The Economics of Improvement in Intellectual Property Law*, 75 TEXAS L. REV. 989, 1047 (1997) (patentee does not have exclusive control over further improvements); Robert P. Merges & Richard R. Nelson, *On the Complex Economics of Patent Scope*, 90 COLUM. L. REV. 839, 875-77 (1990) (based on empirical study, expressing skepticism about ability of holder of a broad patent to coordinate further research and development through "tailored licensing"). John Duffy shows that where others have a small enough incentive to engage in follow-on work or where the patentee can save on transaction costs, the prospect patent holder can coordinate (but not slow down) further innovation, usually through integration rather than licensing, and so avoid duplication. John F. Duffy, *Rethinking the Prospect Theory of Patents*, 71 U. CHI. L. REV. 439, 483-91 (2004). As Duffy points out, development activities that do not (or might not) result in improvement patents are even more firmly under the original patentee's control. *Id.*

⁸² See DONALD S. CHISUM, CHISUM ON PATENTS §§ 17.02[4], 17.05, 19.04 (1997).

⁸³ The Federal Circuit has recently taken an expansive approach to what counts as commercial. See *Madey v. Duke University*, 301 F.3d 1351 (Fed. Cir. 2002).

⁸⁴ The trend in patent misuse is to rely less on per se rules and more on rule of reason analysis, which increases the governance-like aspect of patent misuse. See *Virginia Panel Corp. v. MAC Panel Co.*, 133 F.3d 860, 869 (Fed. Cir. 1997) (finding misuse where patentee extended term of patent by requiring royalties after expiration).

given the right to use a patented substance for some purposes (or in some markets but not in others), with royalties to be paid for different amounts of use.⁸⁵

In intellectual property, the nonrival nature of use makes rights more difficult to delineate and enforce. In the case of tangible property, use conflict itself can be the trigger of a right violation or at least bring the violation to the attention of the right holder. Where uses do not conflict in this way, mere use by another does not announce itself in the same way. If so, this is a reason to think that signals tailored to use—governance-type signals—tend to be more costly in the case of intellectual property than in tangible property. All else equal this can push us toward no property rights (open access) or more reliance on exclusion. Thus, in a sense, it is nonrivalness that has some *tendency to polarize the choices of delineation* for intellectual property rights. This can go some way towards explaining the sharp disagreements over the proper strength and scope of intellectual property.

Uses do not always conflict, and more than one ownership regime can govern an asset. Multiple overlapping regimes that can accommodate multiple uses are particularly likely in intellectual property (and are less modular than having a single level).⁸⁶ Intellectual property rights are likely to be semicommons around their edges.

When we focus on property law as opposed to property rights in general, issues of institutional competence are central. The pattern of property law will depend in part on the relative cost of delineation of rights by courts as opposed to participants. Thus, the question is not just the Demsetzian one of whether additional definition and enforcement activity is worth the cost but whether informal or formal contracting, with or without ex post judicial enforcement, is cheaper than ex ante specification of rights by property law.

Property law serves two purposes, both of which are consistent with seeing property as generally more based on rough signals of exclusion and access than is contract. Property can either assign an entitlement in contexts in which further

⁸⁵ See, e.g., Robert P. Merges, *Of Property Rules, Coase, and Intellectual Property*, 94 COLUM. L. REV. 2655 (1994).

⁸⁶ See, e.g., Heverly, *supra* note 30; Smith, *supra* note 30, at 131-32, 138-42. Robert Merges describes a regime under which scientists share with each other for research purposes but enforce rights against commercial entities, in a semicommons-like arrangement. See Robert P. Merges, *Property Rights Theory and the Commons: The Case of Scientific Research*, SOC. PHIL. & POL'Y, Summer 1996, at 145.

bargaining to modify or transfer the entitlement is not likely to take place, or property can furnish the starting point for private bargains. In the latter case, it is likely that contracting will add to the precision of the rights; in addition to simple transfers, parties can contract to subdivide, to modify rights, or to allow access under limited conditions. Parties can also contract over specific uses to which resources can be put. Anything beyond a contract for simple transfer is likely to add to the precision of the collection of rights to the resource and hence increase reliance on the governance strategy. If, on the other hand, no further bargaining takes place, property law has the last word. This can happen because the gains from further precision are outweighed by the costs of further delineation by contract.⁸⁷

What is the problem to be solved in intellectual property? On the commercialization theory of patent law, it is not so much the creation of information as the actions taken with respect to it that make the invention useful commercially. In the commercialization process, rival inputs are used, and the return from such inputs is not easy to measure.

On one version of commercialization theory, it is important that one actor coordinate others in the commercialization process. This is prospect theory, which points to broad rights to allow the owner the authority to coordinate commercialization and development of the invention even after it has been invented.⁸⁸ This modular structure here crucially has a coordinating or command module.

But prospect theory is not the only version of commercialization theory. Others have pointed to the role of patent rights as platforms for contracting.⁸⁹ The patent right

⁸⁷ Or on Demsetz's terminology, the potential externality is an actual externality because internalization is not worth the cost. Demsetz, *supra* note 1, at 348; *see also* Cheung, *supra* note 7, at 518-20.

⁸⁸ *See* Kitch, *supra* note 81.

⁸⁹ *See, e.g.,* Heald, *supra* note 75; F. Scott Kieff, *Coordination, Property, and Intellectual Property: An Unconventional Approach to Anticompetitive Effects and Downstream Access*, 56 EMORY L.J. 327 (2006); Merges note 85.

announces to others who has complementary inputs.⁹⁰ Another aspect is that property as opposed to contract allows for precontractual liability and enforcement flexibility.⁹¹

Intellectual property, like property and organizations, may solve a problem like team production. Sometimes it is easier to give coarse rights over some collection of attributes rather than the attributes or the individual actions of multiple actors in increasing value from the collection. This is more likely where the attributes are complementary and the actions affect each other's productivity positively or negatively, just as team production. In the case of information, then, intellectual property rights allow for a middle-level decentralization: within the module there may be one or more owners but this is largely irrelevant outside the module (e.g., in a market). It is an empirical question where this middle level of centralization is the most-cost-effective method of attributing returns to inputs in the team-production-like problem of developing information.⁹²

The patent allows actors to undertake commercialization efforts with some assurance of a return from their rival inputs. It is true that in principle these contributions could be more finely measured in a grand contractual process, without the need for exclusive rights. That is, providers of inputs with rights to withhold these inputs could theoretically bargain for a payment for providing them. But in the face of team production problems this is not a trivial exercise.

Modular rights serve three purposes. They are a rough proxy for the right to enjoy the return from these rival inputs. Modular rights are also the platform for modification of the flows of returns to rival inputs. And modular rights allow certain actors to modify the modular structure itself. This last is reminiscent of the prospect function and it is only important where the gatekeeping function has a meta aspect: we are unsure about the process and its solution is best handled by one specialist, so that it

⁹⁰ Kieff, *supra* note 89.

⁹¹ See Merges, *supra* note 72.

⁹² If the benefits stemming from nonrivalness are assumed to dominate then "full" decentralization through the public domain, Brett N. Frischmann & Mark A. Lemley, *Spillovers*, 107 COLUM. L. REV. 257 (2007), or high centralization through narrowly tailored rewards, see, e.g., Michael Abramowicz, *Perfecting Patent Prizes*, 56 VAND. L. REV. 115, 123-24 (2003); Steven Shavell & Tanguy van Ypersele, *Rewards versus Intellectual Property Rights*, 44 J.L. & ECON. 525 (2001), might well be superior.

makes sense to delegate the entire architecture of the commercialization process to one party. That will only be true in some cases, and where it is more true the rights that are given will be broader. But it should be emphasized that modularization can be important even where prospects in the classical sense are not necessary.

Modularization allows patents to be treated as property for general purposes. Patent holders can use them as security for loans. Again in a zero-transaction-cost world the intellectual property holder might use the rights to the inputs to commercialization as security for loans—if security interests were even necessary in a zero-transaction-cost world, in which a contract over all states of the world could be costlessly written. In a positive-transaction-cost world, giving a security interest in the inputs to commercialization or to the (difficult-to-measure) financial flows from those inputs is likely to be less cost-effective in many cases than simply to have a property right in the invention itself, which can then be subject to the security interest in favor of creditors.

In other words, patents and other intellectual property rights are like organizations and other property in general in that the short cut over the contracts that do not—and could not—be used instead is a general purpose one. This also allows for asset partitioning between the intellectual property holders. Officials need not even know the purposes to which the modularity of the property rights will be put in order for them to be effective.

Bundles do not remain constant, but rather evolve over time by conscious and unconscious action. The conventional skeptical view of intellectual property rights implies a dim view of a Demsetzian trend toward greater intellectual property protection.⁹³ According to Demsetz's famous thesis, rising resource values should result in the emergence and development of property rights.⁹⁴ I have argued elsewhere that the rights that emerge need not be exclusion rights; under some circumstances an increase in value can lead to more elaborate rules governing use.⁹⁵ For example, increased congestion on a commons can lead to stints and other norms or formal rules of proper

⁹³ See Frischmann, *supra* note 30; but see Harold Demsetz, Frischmann's View of "Toward a Theory of Property Rights," 4 REV. L. & ECON. 127 (2008) (disclaiming normative intent and defending framework).

⁹⁴ See Demsetz, *supra* note 1.

⁹⁵ See Smith, *supra* note 18.

use.⁹⁶ Increases in pollution externalities led to the development of nuisance law and later pollution controls.⁹⁷ If, as seems to be the case, information is becoming more important in the economy and the subject of more commercial activity, what new types of rights if any should we expect to emerge?

The conventional view offers a clear answer: we should expect more attenuation of exclusive rights and expect that any increase in exclusive rights is the result of rent-seeking by producers. On this view, because information is nonrival, the more important it is the more the nonrival aspect should dominate in the design of a legal regime for information. (In a sense, this view adopts the anti-Demsetzian or pessimistic Demsetzian story for the evolution of property rights in information.) More specifically, many who are skeptical of intellectual property make affirmative arguments for the increasing importance of the public domain.⁹⁸ Exclusive intellectual property rights derogate from the public domain and thus suffer from presumptive illegitimacy.

Likewise, pointing to the importance of incentives does not by itself answer the question of whether more reliance on the exclusion strategy makes sense. The importance of the attribution of returns to rival inputs could call for greater precision in the delineation of rights to the use of those inputs—a more articulated governance regime.

Regarding intellectual property as like regular property in solving coordination problems in a modular fashion makes both positions look too hasty. If information is more valuable, tracing its value is likely to be more complex than ever; particularly in the area of commercializing patentable information, the interaction of inventions is likely to

⁹⁶ See Rose Carol M. Rose, *Rethinking Environmental Controls: Management Strategies for Common Resources*, 1991 DUKE L.J. 1, 8-12.

⁹⁷ See, e.g., *id.* at 9-36; see also Smith, *supra* note 18, at S482-83.

⁹⁸ LAWRENCE LESSIG, *THE FUTURE OF IDEAS: THE FATE OF THE COMMONS IN A CONNECTED WORLD* 161 (2001) (contending that the process of enclosure, in which media and software companies propertize information, is stifling innovation in the new economy); SIVA VAIDHYANATHAN, *COPYRIGHTS AND COPYWRONGS: THE RISE OF INTELLECTUAL PROPERTY AND HOW IT THREATENS CREATIVITY* (2001); Yochai Benkler, *Free as the Air to Common Use: First Amendment Constraints on Enclosure of the Public Domain*, 74 N.Y.U. L. REV. 354, 386-412 (1999) (arguing against expanding copyright at the expense of the public domain); James Boyle, *The Second Enclosure Movement and the Construction of the Public Domain*, 66 LAW & CONTEMP. PROBS., Winter/Spring 2003, at 33 (arguing against increased propertization of intellectual property law at the expense of the public domain); Jessica Litman, *Breakfast with Batman: The Public Interest in the Advertising Age*, 108 YALE L.J. 1717, 1725 (1999) (lamenting the inexorable pressure to treat things of value as property).

be more intense than ever. Each product will incorporate increasingly specialized innovations. Furthermore, the very nonrivalness of uses of information makes the problem of attributing returns for appropriation more difficult, because a nonrival use does not announce itself in the same way that a rival use does through its interference with other uses (think of classic crops and cattle). Coordinating all this activity and solving the appropriation problem may well call for more modularity through exclusive rights, not less. Only by ignoring the benefits of the modularity of the intellectual property system can its inferiority in a static or a dynamic sense be argued on theoretical grounds alone. The nonrival aspect of information does not preclude a need for a modular exclusion-based system to solve the coordination of commercialization when not all the inputs to the process are nonrival.

Thus, for more reliance on exclusion to make sense on the model presented here, we would have to be sure of two conditions. First, the benefits of exclusive rights must have risen faster than the costs of establishing them. Second, the relative costs of exclusion and governance must favor exclusion at the higher level of property rights delineation effort. Again, how far the benefits carry us along the supply curve of property rights and how components of that curve for exclusion and governance may have shifted relative to each other are the essential empirical questions, not simply the rising importance of incentives or of information.

If it is modularity that makes intellectual property rights most like property, this opens up avenues for empirical guesswork. As organizational theorists apply modularity theory to the production of artifacts, we might look for analogs of the intellectual property system on smaller scales where the designers of the system have incentives to get things right.⁹⁹ One theme that emerges from the organization literature on modularity is that modularity of the production process can be implemented by providing for modular design of the product itself: by specifying only how components must combine (the interface), the within-module decisions can be made independently. This keeps many options open because there is less need to commit to a decision for the sake of other decisions relevant to other components. There is a tendency for organizations to

⁹⁹ The management and economics literature applying Simon's theory of modular systems to organizations is a start. *See supra* note 40 and accompanying text.

reflect the artifacts they design and produce.¹⁰⁰ Furthermore, the question whether firms should choose to bring a transaction within the firm or pursue it in a market—and, if within the firm, within a more articulated divisional structure or team—is parallel to the question of modularity in property. As noted earlier, the boundaries of a firm render the nexus of contracts more thing-like and partake of some of the information-cost advantages of the exclusion strategy. Once we better understand these areas and their similarities and differences, developments in one area—such as private contracting in the setting of business organizations—can provide some clue as to the benefits and costs of exclusion and forms of governance in other areas—such as intellectual property. We have to make do with the best information available. But looking for such analogies as suggested by a theory of wide applicability throughout human activity and cognition is likely to be an improvement over the current state of empirical knowledge

IV. MODULARITY AND MEASURING THE BUNDLING OF RIGHTS

Property modules allow for bundling that is not captured by regarding a bundle as the mere sum of its constituents. In property, the exclusion strategy results in property being not just a bundle of sticks but as something more—something that high transaction costs preclude us from accomplishing by contract. One of the functions of property is that it is a shortcut over all the bilateral contracts (or regulations) that would have to be devised for every pair of members of society in all their various interactions. Likewise a firm is a nexus of contracts, but the firm has special modular bundling features that are not achievable by contract unaided by the property-like aspect of organizational law. And intellectual property law provides a modular platform for the interactions of parties, especially when it comes to commercialization. Although exclusive rights have their costs—and because the nonrivalness of information itself these costs are more apparent in intellectual property than in property or organizational law—the modular bundling in intellectual property can serve to manage the complexity of coordinating rival inputs to commercialization.

¹⁰⁰ BALDWIN & CLARK, *supra* note 10, at 91-92.

A thought experiment captures the role that modularity plays in the basic architecture of property, organizations, and intellectual property. Legal relations are superimposed on a set of actors and activities. Let M be the set of m actors and L the set of interactions between them. This can be model by a graph with nodes M and links L . A world in which the legal system tracked every potential interaction would be modeled by the full graph, illustrated below for $m = 10$.

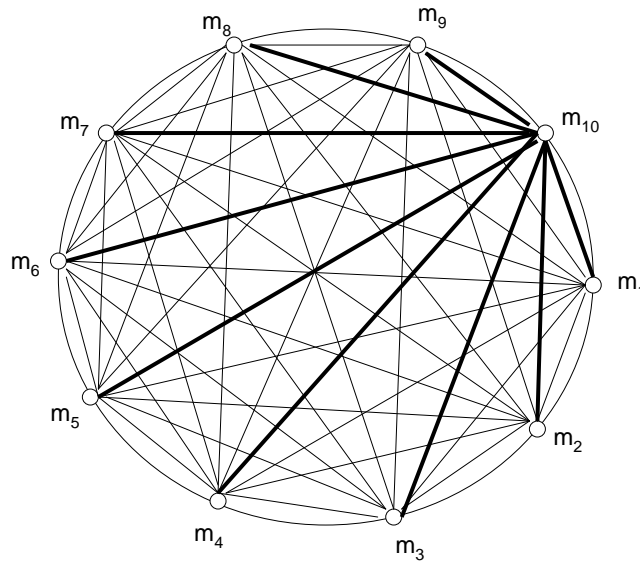


Figure 3 – Complete Graph, $m = 10$

Pick one node, say m_{10} . Compare the value of the least valuable link with the cost of the complexity it adds. The benefits of the link are likely to be linear, especially because other links can serve as substitutes. But from a complexity point of view, the last link, say (m_{10}, m_5) , causes each of the nodes to link indirectly with every other node. Thus, as is familiar in modularity theory, the complexity costs are exponential.¹⁰¹ In the complete graph or in other words the fully nonmodular system, each added node m_n adds $n - 1$ links to the system, as illustrated in Figure 3 by means of the heavy lines for the links

¹⁰¹ See generally MODULARITY IN DEVELOPMENT AND EVOLUTION (Gerhard Schlosser & Günter P. Wagner eds., 2004); Lauren W. Ancel & Walter Fontana, *Plasticity, Evolvability, and Modularity in RNA*, 288 J. EXPERIMENTAL ZOOLOGY 242 (2000); Günter P. Wagner & Lee Altenberg, *Complex Adaptations and the Evolution of Evolvability*, 50 EVOLUTION 967 (1996); John J. Welch & David Waxman, *Modularity and the Cost of Complexity*, 57 EVOLUTION 1723 (2003).

radiating from node m_{10} . This suggests that anything close to the nonmodular system will far from optimal.

In many systems including the property-tort-contract-restitution system, i.e. basic private law, most links will not be very relevant, or will be weak. (Each link can be associated with a strength, but for simplicity's sake we assume for now that all links are of equal strength.) Although the level of modularity that is most suited to a system depends on empirical evidence that we partially possess, as mentioned earlier there is a large literature on optimal modularization. This in our example, if the system is nearly-decomposable, we can group the system into modules. An easy case is illustrated in Figure 4:

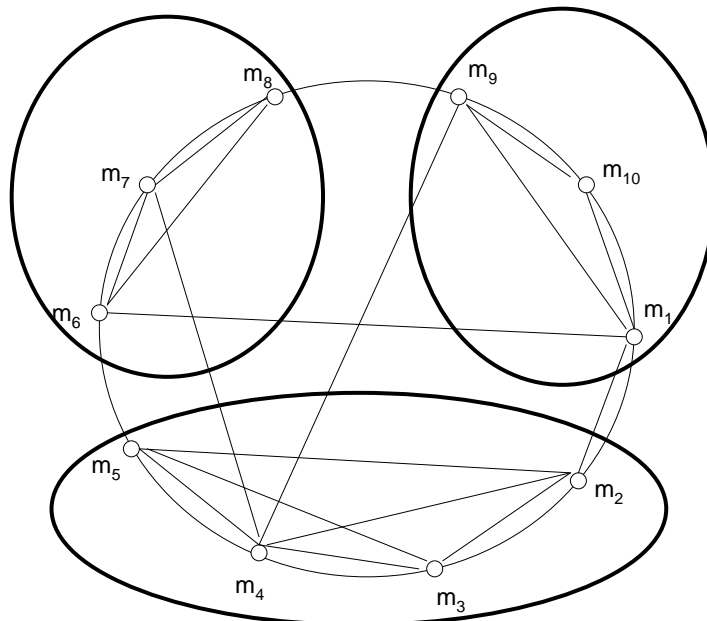


Figure 4 – Modular System, $m = 10$

In this example all the nodes within each module are interconnected. As for relations between modules, they are much more sparse. Here the pattern of interactions indicates three modules with the interface between the left (m_6 - m_7 - m_8) and bottom (m_2 - m_3 - m_4 - m_5) modules consisting of the link (m_4, m_7) , the interface between the right (m_1 - m_9 - m_{10}) and bottom modules consisting of the links (m_4, m_9) and (m_1, m_2) , and the interface between the left and right modules consisting of the link (m_1, m_6) . If we wanted further modularization one or more of these four interface links would have to be suppressed, at some positive cost.

Now consider the alternatives to modular property. One alternative would be a generalization of the law of tracing.¹⁰² Tracing allows a plaintiff's claim to relate to a succession of assets and to follow the assets into remote hands. Thus if B steals A's car, sells it for \$10,000 and puts the money in B's own bank account, A can claim the \$10,000 in the account. Because B is a wrongdoer, presumptions work in A's favor. So if the bank account had \$5000 before "A's" \$10,000 was added, B adds the \$10,000 and then withdraws \$5000 to bet at the racetrack, A can claim B's winnings. It is presumed that B used A's \$10,000 to win at the track. If however, B loses the \$5000 at the track, then we trace A's claim to the amount still in the account. Sometimes tracing claims can follow an asset in a transfer from B to C, for example if B stole A's car and gave it to C. American law with only a few exceptions enables A to claim the car back even if C paid for it, leaving C with a claim against B.¹⁰³ The law, however, does not allow unlimited tracing, and makes tracing available mainly where the primary actor involved is a wrongdoer. We could imagine generalized tracing, where property claims were made in the narrowest fashion and the claims would float around, impacting those who interact with the assets in question. Thus, A might improve an object and have a lien that travels with the object into remote hands. We could imagine various liens interacting with each other, extinguishing each other, and so on. The more levels of tracing we allow and the more general the contexts in which we allow it, the closer we come to a property system that would look like the complete graph in Figure 2. In intellectual property, someone might, for example, be able to claim an inventive contribution and then "trace" its effects to remote hands and make a claim against all remote beneficiaries.

Our property system is not like this, and it is worthwhile to consider why it is not. The full tracing system would be like coupling a tort law with no limits like foreseeability

¹⁰² See, e.g., Peter Birks, *Mixing and Tracing: Property and Restitution*, in 45 CURRENT LEGAL PROBLEMS 69, 84 (1992) (exploring tracing in restitutionary claims); DAN B. DOBBS, LAW OF REMEDIES: DAMAGES-EQUITY-RESTITUTION §6.1 (2d ed. 1993) (discussing the necessity of tracing); Peter B. Oh, *Tracing*, 80 TUL. L. REV. 849, 876 (2006) (examining remedial tracing in equity and at common law).

¹⁰³ See, e.g., JOSEPH WILLIAM SINGER, INTRODUCTION TO PROPERTY § 16.2.5 (2d ed. 2005). Other legal systems favor good faith purchasers in more circumstances. See, e.g., Saul Levmore, *Variety and Uniformity in the Treatment of the Good-Faith Purchaser*, 16 J. LEGAL STUD. 43 (1987). Purchasers with notice are generally not protected. See generally Benito Arruñada, *Property Enforcement as Organized Consent*, 19 J.L. ECON. & ORG. 401 (2003).

or duty constraints with an unlimited law of unjust enrichment. Actual tort law places severe limits on which contextual variables are relevant,¹⁰⁴ and unjust enrichment is even more limited in its scope with respect to nonconsenting parties.¹⁰⁵ Property law limits interdependencies even more severely, as we have seen. Most of the possible interactions between any arbitrary pair of actors are weak or nonexistent. So ruling them out in principle is low cost. At the same time ruling such interactions out—simplifying the interface between modules—is likely to decrease complexity costs for the reasons discussed earlier.

Theoretically, tracing is a close functional substitute for lumpy exclusion-based property, but contracts are also worth considering. In a world of no transaction costs we could do all the tracing by means of consensual contacts. Of course we can't, because of transaction costs, but one might ask whether the possibility of contacting keeps all the links alive and therefore makes the modularity-based theory inapplicable. To this it can be pointed out that the law of property does *not* allow unlimited contracting. One interpretation of mandatory standardization in property through the *numerus clausus* and related devices,¹⁰⁶ is that property prevents contracting from undermining the basic modular architecture of the system.

What this thought experiment shows is that some (severe) limits on interdependencies are likely to be worthwhile and that the basic property element in property law proper, organizations, and intellectual property can be seen as serving this function. What we still need is a theory of which modules and interfaces are (and should be) chosen, and how decentralized the modularization of the system should be. Work on community structure and optimal modularization can be a source of testable hypotheses. In particular, the application of network theory, community structure, and the notion of

¹⁰⁴ See James M. Anderson, *The Missing Theory of Variable Selection in the Economic Analysis of Tort Law*, 2007 UTAH L. REV. 255.

¹⁰⁵ Andrew Kull, *Rationalizing Restitution*, 83 CAL. L. REV. 1191, 1196 (1995); Emily Sherwin, *Restitution and Equity: An Analysis of The Principle of Unjust Enrichment*, 79 TEX. L. REV. 2083 (2001); *but cf.* HANOCH DAGAN, *THE LAW AND ETHICS OF RESTITUTION* (2004) (arguing for an expansive role for restitution).

¹⁰⁶ See Merrill & Smith, *supra* note 52.

the strength of ties to social networks is well-established.¹⁰⁷ These theories, along with the organizational modularity literature can draw on general modularity theory. These implications I leave for further work, but modularity theory provides some hypotheses about the tradeoffs and some pointers to empirical evidence.

If property serves as an architectural device—not just in property proper but in organizations and intellectual property as well—then the question becomes whether and how one can measure its effects empirically. In this Part, I will suggest how the modular, architectural view of property presents some challenges to conventional law and economics. I will then turn to the type of empirical work made possible in principle by a better theory of the architecture of property.

The conventional empirical approach to studying economic institutions presupposes the stick-by-stick bundle of rights view of property. In general this empirical work tends to ask whether this or that legal rule has some property like efficiency, or correlates with some effect that in turn has implications for efficiency or fairness. Obviously micro features of the law are hard to isolate in this sense, and one has to assume that background conditions are being held equal. It is hard to say that the same progress has been in property as in torts or contracts. We have some understanding, for example, of the effects of tort reforms and different regimes of employment contracts (at will, for cause).¹⁰⁸

This is where the modularity theory has the potential to be helpful. First of all, modularity theory provides an explanation for why certain aspects of property have been more amenable to the conventional approach than others. Governance rules are more like the rules of contracts and torts and impinge on identified persons. For this reason, we can try to connect variation in those rules with a micro theory of individual behavior. And the behavioral response to changes in the rules is likely described by some linear function.

¹⁰⁷ See, e.g., Aaron Clauset, M.E.J. Newman & Christopher Moore, *Finding Community Structure in Very Large Networks*, 70 *PHYS. REV. E* 70, 066111 (2004); M.E.J. Newman, *Modularity and Community Structure in Networks*, 103 *PROC. NATL. ACAD. SCI. USA* 8577 (2006). For a discussion and an application to community custom, see Henry E. Smith, *Community and Custom in Property*, 10 *THEORETICAL INQUIRIES L.* 6 (2009).

¹⁰⁸ See, e.g., David H. Autor, John J. Donohue III, & Stewart J. Schwab, *The Costs of Wrongful-Discharge Laws*, 88 *REV. ECON. & STAT.* 211 (2006); Anup Malani, *Introduction: Current Research in Medical Malpractice Liability*, 36 *J. LEGAL STUD.* S1 (2007).

If so, some parts of property law are more susceptible to this approach than others. Thus, the refinements and extensions of the governance strategy can more easily be isolated, and regimes with and without them might present sufficient variation against a nearly constant (or at least unbiased) backdrop of the rest of the property regime.

But what of the exclusion strategy? The bundle-of-rights view would regard this as one more feature that can be turned on or off, or dialed up or down. And in a narrow sense that is true. But if the exclusion strategy is a primary vehicle through which property attains a modular structure, we have to be on the look out for more systemic effects. These are not likely to be easy to isolate, for several reasons. There is a danger in isolating chunks of the property system that do not constitute a module. If we allow such pseudo-components to vary, we are either likely to mistake what true variation is or we are likely not to find anything interesting. On the flip side, modularity theory generates hypotheses about what constitutes a “component” worth studying. In other words, the modularity-based theory gives us some handle on the granularity of the economic phenomenon.

Likewise, the information-cost theory directs us to potential case studies. One method for doing so is to look at smaller structures like business organizations to get a suggestive idea about larger property issues. This of course is fraught with perils relating to the scalability of the structures in question. But as one avenue of investigation, this is likely to be worthwhile.

Further, as I have shown in earlier work, the information-cost theory generates predictions about the likely direction of change, in a Demsetzian sense.¹⁰⁹ We do not need to know the exact size of various quantities in order to be able to predict a move from exclusion towards governance or vice versa. Returning to the model illustrated in Figure 1, consider a few of the propositions that one can derive from it. As marginal benefit shifts outward (inward) we expect, in Demsetzian fashion an increase (decrease) in property rights activity.¹¹⁰ But because the supply curve is made up of components reflecting the various strategies, we can predict a shift from exclusion to governance (or

¹⁰⁹ Smith, *supra* note 2, at S477-78.

¹¹⁰ See, e.g., Terry L. Anderson & P.J. Hill, *The Evolution of Property Rights: A Study of the American West*, 18 J.L. & ECON. 163 (1975); Demsetz, *supra* note 1; Smith *supra* note 2.

in a more elaborate version of the model, a finegrained efforts at exclusion).¹¹¹ An example would be the increasingly stringent rules of ruse of grazing commons in medieval and early modern England before enclosure.¹¹² Moreover, as the various components of the supply curve of property rights – the individual strategies – differ or change in cost, we can predict shifts in the relative reliance on exclusion and governance. For example, we can compare patent law and copyright law in terms of the relative difficulty of setting up modular exclusion-style boundaries versus individualized governance-style rules of use, to explain why patent law is more property-like than copyright, as well as some changes over time.¹¹³ Likewise, exclusion in the case of water is difficult and the high cost of modularization helps explain why water law has – both in its riparian and more surprisingly in its prior-appropriation versions – is more reliant on governance regimes than other areas of property.¹¹⁴

More generally, we first need a theory that gives us candidates for what constitutes a component of the system in order to ask the right questions. All empirical work requires a theory, and I am suggesting that the theory needed in NIE to study property rights needs more of an architecture than the conventional view of property as an arbitrary collection of bare entitlements without much architecture would suggest.

* * *

In this paper I have emphasized the benefits of modularity in terms of managing complexity. These benefits do not come without cost. Modularization may preclude interdependencies of some value or may overlook interdependencies that exist and cause unanticipated trouble.¹¹⁵ Relatedly, conditions can change and call for a different modularization. Although under a wide variety of circumstances, modular systems

¹¹¹ Smith, *supra* note 2, at S464-78.

¹¹² *Id.* at S478-83.

¹¹³ Smith, *supra* note 69, at 1799-1819.

¹¹⁴ Henry E. Smith, *Governing Water: The Semicommons of Fluid Property Rights*, 50 ARIZ. L. REV. 445 (2008).

¹¹⁵ See Oliver Baumann, *Coordinating Search in Modular Systems: The Value of (Temporary) Integration* (Munich School of Management Draft Mar. 21, 2008), available at SSRN: <http://ssrn.com/abstract=1113174>.

evolve more easily than nonmodular systems, modular systems can get stuck at local optima depending on how much modules can vary and whether variation is random or rationally selected.¹¹⁶ Particularly promising are studies of modularity that allow for decentralized search and sporadic intervention by a control module (like official decisionmakers or other coordinating institutions) or special intermodular communication (like contracting) in order to improve the evolutionary path of the modular system under changing conditions.¹¹⁷

The modularity furnished by property law is can be found at the foundations of organizational law and intellectual property. The bundle-of-rights theory of property, the nexus-of-contracts view of organizations, and the regulatory view of intellectual property are not wrong but they are incomplete. In the case of organizations, the property element is easy to overlook but ties together many strands of literature that have drawn out aspects of organizations that do not fit comfortably in the nexus-of-contracts theory. Because of the nonrivalness of information, any property element of intellectual property is bound to be more controversial and in need of more empirical investigation, but neither the nonrivalness of information nor the need for incentives is the end of the story. Intellectual property, like property and organizations, can be seen as the solution of a complex coordination problem of attributing outputs to inputs. In the intellectual property area, different actors combine inputs with something that can be said to belong to the public. As long as the innovator's or commercializer's rival input is valuable enough and the overall coordination problem of investment, appropriation, and consumption is complex enough, the theory of systems and our experience with human artifacts should lead us to expect a major role for modular solutions.

¹¹⁶ See Stefano Brusoni et al., *The Value and Costs of Modularity: A Problem-Solving Perspective*, 4 EUR. MGT. REV. 121 (2007) (exploring trade-off between speed of search through modularity and lock in to suboptimal solutions); Luigi Marengo et al., *Decomposability and Modularity of Economic Interactions*, in MODULARITY: UNDERSTANDING THE DEVELOPMENT AND EVOLUTION OF COMPLEX NATURAL SYSTEMS 835 (Werner Callebaut and Diego Rasskin-Gutman eds., 2005). Baldwin & Clark, *supra* note [10], assume a rationally designed search.

¹¹⁷ Baumann, *supra* note 115.

CONCLUSION

Property, with its boundaries and rights of exclusion indirectly protecting an indefinite range of internally interacting uses, makes the system of commercializing innovation more modular. In organizations, intellectual property, and property more generally, exclusion strategies—as modified at the interfaces between modular rights by governance rules—furnish, at some positive cost, modularity to the system of providing inputs and appropriating benefits from assets. Ultimately, the desirability of any institutional scheme, including intellectual property, is an empirical question.