Intellectual Property Rights, Input Markets, and the Value of Intangible Assets

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Abstract

Intellectual property rights (IPRs) appear to play an important role in facilitating production and exchange in certain input markets. This paper provides a simple theory about the relationship between stronger IPRs and contract-based production under assumptions of incomplete contracting. Employing some features of Grossman and Hart, Hart and Moore, and Hart (1995) ("GHM"), it is shown that property rights over intangible assets create incentives for independent supplier firms to produce research and development (R&D)-intensive inputs for use by downstream producers of a final product. Legal rights over intellectual property allow these important assets to be "owned," in the GHM sense of providing residual rights exercisable in the event of incomplete contractibility. Weak or nonexistent property rights create severe misappropriation risks for firms with intangible assets who must adapt them to make a specialized input. Once property rights are created or strengthened, it is feasible in some cases for an input maker to constitute itself as an independent firm, rather than as an integrated unit inside a larger firm. Asset ownership can then be allocated per standard GHM theory to provide proper incentives to make investments specific to the supplier-manufacturer relationship. In this way, IPRs are seen to contribute to an increase in the value of underlying assets, and hence ultimately to firm specialization and even industry structure. The theory of this paper accounts for recent empirical evidence linking stronger IPRs to a greater incidence of licensing activity. It also contributes to the ongoing modification of the economic theory of property rights associated with the early work of Harold Demsetz (1967).

1. Introduction[1]

The economic literature on intellectual property rights (IPRs) customarily views property rights and product markets as coextensive. The literature on optimal patent scope, which emphasizes transactions between technological pioneers and improvers, is a notable exception.[2] Outside this literature, it is still common to assume (however implicitly) that one and only one property right covers the entirety of a marketable product.

This is not now, and for the most part never has been, how things really work. A commercially viable product will quite often be assembled from a number of components. At least some of these will be covered by IPRs; in many cases, components will be manufactured by independent firms, which in turn own any associated IPRs. Thus what is often missing in the literature is a discussion of what might be termed the IPR-related *input market*. This is a paper about that market.[3]

One motivation for writing this paper is to say something systematic about this market, and then to ask how it might affect our thinking about IPRs. We are so accustomed to discussing IPRs and modelling them as if they were embodied in an end product sold to consumers, opening an explicit discussion on the input market might reveal something interesting about IPRs. We have

[1] Thanks to (and disclaimers for) Ashish Arora, Ron Gilson, Oliver Hart, Thomas Hellman, Naomi Lamoreaux, Mark Lemley, Peter Menell, Suzanne Scotchmer, Oliver Williamson and Luigi Zingales, and workshop participants at the Haas School of Business, U.C. Berkeley, and Columbia Law School.

[2] *See, e.g.*, Merges and Nelson (1990).

[3] To be precise, it is a paper about the market for products covered by IPRs, as distinct from the market for IPRs themselves. A tripartite taxonomy of markets (for tangible assets; information; and IPRs) is described in Merges (1995).

begun to see in other settings that sensitivity to the life of a property right after it is initially granted – the pattern of transactions in which it is exchanged, and the institutions that grow up to facilitate this exchange – may reveal much about the optimal nature of the right, or even about the wisdom of granting it in one form or another.[4] A second motivation is the sense that the market for inputs covered by IPRs is growing rapidly. There is abundant evidence that the production of R&D-intensive inputs is increasing dramatically.[5] This is simply the flip-side of the well-documented increase in the decentralization of production, and in particular of R&D-intensive production. Reversing the trend of the past century,[6] small specialty firms appear to be increasing their share of overall R&D. Whereas in the past, large firm vertical integration into R&D-intensive markets was the norm, today the economic landscape appears to be much more diverse. While vertical growth, typically via acquisitions, is of course still common, large firms often "partner," via a dizzying array of organizational forms, with small firms steeped in new technologies. Joint ventures, R&D partnerships, corporate venture capital, spinoffs, startups, licensing deals, and "out-sourcing" arrangements (i.e., purchase of components formerly manufactured in-house)– all forms of "strategic alliance" have been adopted widely in recent years (Merges, 1995).

In this paper I am concerned with the economic function of IPRs in these alliances. It is clear that IPRs are important; the data show that, especially in certain industries, IPRs are central to input transactions. Particularly in biotechnology, but also in software and other industries, IPRs cover virtually all products sold as inputs to larger firms. Issues such as permitted uses, re-use, and alteration of products sold as inputs occupy a great deal of attention in negotiations, and lead

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[4] Libecap and Wiggins (1985); Merges (1997a); Heller (1998).

[5] *Cf.* Stites (1998: C4) ("Early-stage investing can help corporations tap entrepreneurial creativity lacking in their own halls and, when investing in technologies that complement their own, to save money in research and development.")

[6] Mowery and Rosenberg (1989); Lamaroux and Sokoloff (1996) ((discussing historical trend toward differentiation of inventive function from commercialization).

to litigation in a growing number of cases.[7]

On one level, this is not surprising. IPRs are the "crown jewels" of many small firms with nascent manufacturing and distribution facilities. But on another level, the growing frequency of inter-firm collaborations actually seems to be *driven*, at least in part, by IPRs. The trend toward clearer and stronger IPRs, together with the widening awareness of the strategic deployment of these rights, has significantly increased the importance of IPRs in interfirm dealings. The consequences of this important new dimension, which I call by the shorthand *IPR intensity*, are at the heart of this paper. In short, IPR intensity makes possible a greater volume and variety of interfirm collaborations than before; and therefore at least some interfirm input arrangements are a result of the new emphasis on IPRs.

If this argument is correct, it highlights some interesting interactions between two of our most basic legal categories, property and contract. A change in the specification[8] of property rights expands the horizons of potential contracting parties. One might say the state-backed property right shifts the "contract possibility set" outward. It is far from novel to observe that in our system, the state typically issues property rights and then stands back while "private ordering" rearranges things satisfactorily (bracketing those troublesome distributional issues, of course). But in this paper I add two ingredients to this old recipe. First, I analyze in micro-detail one *particular* instance of the property-contract interaction; this puts some flesh on what is usually a barebones

[7] Sandburg (1989) (describing numerous disputes arising out of strategic alliances).

[8] Property is normally thought of as a bundle of rights issued by the state. This is the basic conception followed here, but with a minor addition: I take an increase in the *awareness* of property rights and transactional techniques involving them as equivalent to an expansion in the set of rights issued by the state. If, in other words, people and firms become aware for the first time that tradable assets can be the subject of property rights, or if they grow in sophistication regarding how the rights can be deployed, that has the same effect as when the state clarifies or strengthens rights through legislation or court decisions. The process is driven by diffusion of information about ways private actors can combine property rights with contracts to expand organizational options.

"stylized" story. Second, this paper describes the larger ramifications of the outward shift in contracting. It describes how new contracting possibilities enable novel organizational forms, and how those forms may even come to change essential features of the industrial landscape, such as industry structure (i.e., number and size distribution of firms in an industry). In so doing, this paper suggests – however primitively, and certainly tentatively – a bridge between the basic building blocks of property and contract, and larger-scale issues such as "firm boundaries," choice of organizational form, and industry structure.

1.1 Structure of the Argument

This Article sets forth a concise theory to explain how IPRs affect transactions. Using the "new" property rights approach developed by economists over the past ten years, Part 2 explains that IPRs can fruitfully be seen as residual ownership claims over intangible assets. This is shown to create the conditions for (more) efficient *ex ante* investment where an input supplier must make relationship-specific investments in anticipation of a transaction with an input buyer. Part 2 concludes with an example from the biotechnology industry which illustrates the real-world relevance of these theories. Part 3 provides two sorts of empirical support: data from a recent paper by Anand and Khanna (1997) showing a tight relationship between the volume of IPR licensing and the strength of property rights across industries; and a brief account of the rise of a robust chemical intermediates sector in chemical and pharmaceutical manufacturing industries – a case study of an industry characterized by patent-intensive input supply relations. Part 4 generalizes the discussion. It notes that stronger IPRs can actually induce creation of more valuable assets. This "feedback" effect from the property rights specification to the value of the underlying asset represents a fundamental modification of the now-dominant "naive" model of property rights specification, closely associated with the early work of Harold Demsetz. Part 5 concludes.

2. The "New" Property Rights Approach

Scholars such as Nobel-winner Douglass North have since the 1970s been aware of the important economic function of well-specified property rights.[9] This literature has generated a number of interesting ideas, as well as a few testable hypotheses. (We return to one, the "naïve theory" of property rights, in section 4 below.) At the same time, it is true that the early literature on property rights suffered from a lack of precision. It taught the general importance of efficient rights, supplemented by private ordering. But it did not explain a number of details of interest, especially the micro-analytics of the interaction between property rights and contracting.

The 1980s saw a new attempt to frame these issues more rigorously. This approach begins with two key assumptions drawn from related economics scholarship: (1) the concept of incomplete contracting; and (2) the notion of property right ownership as a function of control over "residual" uses of an asset. Oliver Hart, a leading exponent of the "new" property rights approach, explains the key importance of the second concept, "residual control rights," as follows:

> Given that a contract will not specify all aspects of asset usage in every contingency, who has the right to decide about missing usages? According to the property rights approach, it is the owner of the asset in question who has this right. That is, the owner of an asset has *residual control rights* over that asset: the right to decide all usages of the asset in any way not inconsistent with a prior contract, custom, or law. In fact, possession of residual control rights is taken virtually to be the definition of ownership.[10]

Residual control, or ownership, is important because of the second key assumption:

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[9] See North (1990) for an overview.

[10] Hart (1995: 30).

contracts are incomplete. It is impossible to write a contract delineating which party has which rights under all possible states of the world.[11] This in itself seems straightforward: legal scholars have noted the significance of property rights as "off the shelf contracts," governing legal relations in the absence of affirmative contracts (or legal "privity") (Merges, 1997). The details of IPR law reflect this core idea of controlling residual uses. Licensees infringe an IPR, for example, when they operate even slightly outside the scope of their license; residual uses are by default controlled by the IPR owner. Control of residual uses is also evident in the remedy for breach of an IPR: injunctions issue virtually automatically in cases of licensee breach.[12]

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[11] Harold Demsetz, one of the pioneers of the economics of property rights, has criticized the use of the incomplete contracting assumption in the new property rights approach. *See* Harold Demsetz, Book Review of Oliver Hart, Firms, Contracts, and Financial Structure (1995), 106 J. Pol. Econ. 446 (1998). Demsetz argues that although it may be impossible to specify all contingencies under a contract, it is not impossible to write a contract that protects a specified (or "nonresidual") use of property from being undermined by uncontemplated, future contingencies ("residual" uses). As a consequence, Demsetz questions the assumption in the "new" property rights literature that ownership is tantamount to control of the unspecified residual. There is certainly some support for Demsetz' critique in the real world; biotechnology licensing agreements contain very detailed parsings of many aspects of ownership of patent rights, conforming in some ways to Demsetz' statement (at p. 450) that "[w]hen different parties own different rights in the same asset, it is better to speak of party A owning some rights in the asset, party B owning other rights, and so on." *See* Josh Lerner and Robert Merges, The Control of Strategic Alliances: An Empirical Analysis of Biotechnology Collaborations, 46 J. Ind. Econ. 125, 134 n. 4 (1998). Yet at the same time the law does seem to recognize the notion of residual control rights. In fields as diverse as intellectual property licensing and real estate transactions, there is a time-honored rule that rights not explicitly granted in a contract remain with the legal owner of the right. *See, e.g.* S.O.S., Inc. v. Payday, Inc., 886 F.2d 1081, 1088 (9th Cir. 1989) ("copyright licenses are assumed to prohibit any use not authorized"). Perhaps the more accurate view is therefore that control rights can be parsed much more finely than the "new" property rights literature typically suggests (i.e., simple one-shot exchange under specified conditions, versus all residual rights), but that even so the core notion that residual, unspecified uses remain with the owner retains explanatory power.

[12] *See, e.g.* Curtis (1849: 240); Merges (1994). One advantage of these policies from the point of view of the licensor is that they insure that an IPR will retain its status as a property rule entitlement **C** an entitlement that must be purchased only from the holder, *at the holders' reservation price* **C** even in the presence of a contract. This of course varies from the normal rule in contract law, where a breaching party pays damages, i.e., compensation as set by a court, rather than facing an injunction and having to deal with the non-breaching party on her own terms. *See*

The notion of the residual simply embellishes a concept almost as old as property itself. It is certainly implicit in the bedrock distinction between granting a property interest and entering into a contract. (Think of a real property license versus a lease, for instance.) The new property rights approach therefore adds nothing new to our taxonomy of legal interests. What is significant about the property rights approach and where the payoff comes for this paper, is its analysis of the *allocation* of property rights. This literature recognizes the important incentive effects that follow from control of residual uses. It analyzes differing incentives that follow from assignment of ownership (i.e., residual control), in particular, incentives for relationship-specific *ex ante* investment in anticipation of a future trade with a particular party (Grossman & Hart, 1986; Hart & Moore, 1990; Hart, 1995) (referred to collectively as "GHM").

The "new" (GHM) property rights approach thus stresses the incentive effects of ownership: proper allocation of ownership over an asset *ex ante* gives rise to an incentive to tailor its output to the needs of a buyer, who incorporates that output into a final product for sale on the open market. In this literature, assets are machines and techniques; the asset used to produce the final product is denoted a1, and the asset used to make the input into this final product is a2. There are two managers (or firms), m1 and m2. Ownership of the assets is either "integrated" (i.e., either m1 or m2 owns both) or "independent" (each owns one, typically, m1 owning a1 and m2 owning a2). The core idea is that the proper ownership structure creates the right incentives to invest in the use of the asset. Knowing this, the parties engage in Coasean exchange. They allocate ownership so as to maximize net joint profits after the input is traded. Thus there may be two exchanges between m1 and m2: property rights are allocated at "T_0," before specializing investments are made; then the input is traded later, at T_1. Naturally, if property rights are in the hands of the "proper" (value-maximizing) parties at the outset, no re-allocation will take place at

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Schwartz (1979). For a defense of this strong property rule presumption for IPRs, see Merges (1994) (arguing that IPRs are idiosyncratic assets, characterized by difficult valuation problems, and hence ought to be protected almost always by a property rule).

T_0.[13]

The "new" property rights models are careful to specify that the investments at issue are not investments in the assets themselves; it is thought that these investments would be easy to specify by contract.[14] Typically what is at stake are investments in intangible and difficult-to-verify knowledge and skills that more closely adapt the use of asset a1 to the needs of m2. The investment is often thought of as being in "human capital." By their nature these adaptive investments are both relationship-specific (i.e., of highest value when the output of a1 is sold to m2, rather than on the open market) and impossible to specify in an enforceable contract. Allocation of ownership rights over a1 is therefore used in place of a contract to better align the incentives of m1 with those of m2.

Technically, under the right circumstances ownership of an asset increases the owner's "threat point" in a negotiation over the future sale of the asset's output. It does so because, by assumption in the models, asset ownership increases the owner's return in the event of no exchange at T_1 – i.e., the manager who owns an asset can earn more than he or she would have if not an owner. Of course, this is so only when the asset in question can be used to make a product for sale to others, for example on some "spot" market. Following standard bargaining models, an increase in the owner-manager's threat point lowers the amount of the joint surplus (i.e., "value-added" flowing from the making of a deal) that the owner-manager must give to the other party in

[13] This assumes of course that the benefits from each party's ownership are known at T_0, and that both parties have enough money to compensate the other for a transfer of ownership. Because owning assets always increases a party's private returns, to reach the superior joint product the "efficient owner" will have to compensate the other party when he or she gives up ownership. Where the other party will gain more from ownership, this transaction will be worthwhile; he or she will compensate the other out of the prospective gains that follow from ownership. Of course, this assumes that both parties have adequate cash resources at T_0, an assumption that is discarded in the contribution by Aghion and Tirole (1994), discussed below at section 2.3.

[14] Aghion and Tirole (1994) is an exception; these authors view the "innovation" to be created by a "research unit" as the subject of the exchange to take place at T_1.

the negotiation.[15] Thus the increase in the threat point that follows from ownership allows the owner-manager to capture more of the value she creates via the "adaptive investments" described earlier. Property rights, to borrow a term from a related literature, serve as an "appropriability mechanism" in the context of relationship-specific investments (Teece, 1986). Without property rights to increase one's threat point (i.e., increase one's returns in the absence of trade), one will receive only *half* the value created by an investment. Cooperative surplus must be split 50:50, by convention. But with property rights, the threat point increases. Under the right circumstances, a higher portion of one's investment can thus be recouped. The property rights approach thus preaches the importance of ownership as an appropriability mechanism. Ownership, if available, will be assigned by the parties to a person (or firm) whose asset-specific investment is required to make an asset more productive.[16] If ownership rights do not exist, or if they are structurally misallocated (due to inalienability, high transaction costs, or capital constraints), this person may not make the requisite investment, and the economic surplus that would have resulted will go

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[15] *See* Hart at 39, 41. The simple idea is that each party receives their threat point amount, plus half the cooperative surplus in excess of the two threat point amounts. This aspect of the theory has been disputed recently; see Y. Stephen Chiu, Noncooperative Bargaining, Hostages, and Optimal Asset Ownership, 88 Am. Econ. Rev. 882-901 (1998). Chiu re-characterizes the bargaining in the canonical examples in the new property rights literature, arguing that the amount a party can realize via their "outside option" – the alternative course of action, taken in place of a bargained-for exchange with the other party – will determine the maximum compensation they need to be paid by the other party to the deal. If for example m2's outside option yields more than the amount she can realize during negotiations with m1, this outside option value will act as a ceiling on how much m1 must pay in the event of a trade. Chiu argues that m1 can often maximize her own return by making an investment in human capital that increases the value of asset a1's output, *regardless* of who owns a1. Thus even if a1 is owned by m2, in many cases m1 can pay m2 an amount equivalent to her outside option, and still realize positive net returns from investing in human capital specifically tailored to asset a1. The problem with this model appears to be the assumption that m2 is tightly constrained by her outside option. It still appears more realistic to assume, as Hart does, that the parties are paid their threat point values plus half the cooperative surplus. The rigidity of Chiu's outside constraint seems artificial, in other words. A roughly similar argument is put forward in de Meza and Lockwood (1998).

[16] Ownership is in this sense Coasean: it does not matter who has ownership of the asset at the outset, since if assigning ownership to one or the other party will leave them both better off – by enabling them to realize the investment/cooperative surplus outcome – they will do so.

unrealized.[17]

The figures that follow show the m1-m2 transaction. Figure 1 shows the layout of the basic transaction, when property rights exist for both assets.

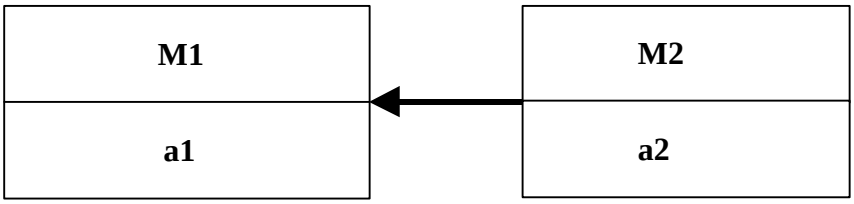

Figure 1 (After Hart (1995))

Before we see how the absence of property rights affects things, a brief overview of GHM models is in order. Assume that if m2 owns asset a2, m2 can use it to produce the input for sale on the spot market as well as for a sale to m1. The spot market price increases with each level of adaptive investment m2 makes. The spot market price will be $30, if m2 makes the high investment; $10, if it makes the low investment; and $0 if it makes no investment at all.[18] By contrast, if m1 owns asset a2, m2 will realize nothing on the spot market; it has no asset with

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[17] *See also* Paul Milgrom and John Roberts, Economics, Organization and Management (Prentice-Hall, 1992) at 137:

> *It is the specificity of assets together with imperfect contracting that lies at the core of the hold-up problem.* Concern about these problems may lead to inefficiencies as firms, fearing that their investments will leave them vulnerable, refuse to make the efficient investment.

[18] This implies that the input produced by asset a2 is completely useless if m2 invests nothing in adapting it; in this sense, some effort at "specializing" the asset is necessary for m2 to realize any value from it. Second, the statement in the text assumes that adaptive investments yield some return whether the input is sold to m1 or on the spot market, but the "yield" on this investment is obviously higher if the input is sold to m1 rather than on the spot market. Investment yields higher returns in either case, but is especially (jointly) valuable when the input winds up with m1.

which to produce an input for sale. Assume that the input is worth $100 to m1 when m2 makes the high adaptive investment; $80 when m2 makes the low investment; and $60 when no adaptive investment is made. Table 1 summarizes the payoffs to m1 and m2 for each level of investment under the two ownership regimes.

Table 1: Payoffs

m2 Investment	m1 Valuation of asset a2 Output	m2 Spot Price (m2 owns a2)	m2 Net Profit (m1 owns a2)
Zero	**$ 60**	**$ 0**	**$ 0**
Low ($ 5)	**80**	**10**	**- 5**
High ($ 20)	**100**	**30**	**- 20**

GHM models show the effect of a2 ownership on the incentives of the parties. Given that m1 ownership leaves m2 with a zero return on the spot market, m2 is in a poor bargaining position at T_0 when m1 owns the asset. To be precise, m2's threat point is zero. This, together with the assumption that the parties cannot enter into an enforceable agreement regarding m2's investment at T_0, means that m2 will invest nothing.[19] If m2 did invest, m1 could extract much of

[19] This is a limiting case. Even though m2's adaptive investments are made for purposes of optimizing the output of patented technology a2 for m1's needs, m2 may learn some techniques, etc., that are applicable to other technologies. It may thus realize some general increase in its productive capacity even if m1 ultimately refuses to buy output from m2. However, it is important to note that most of the value of m2's adaptive investment will be lost if m1 owns the patent, since patent ownership permits m1 in most cases to prevent m2 from selling the output of the patented technology.

the value of the investment in negotiations over the input price at T_1.[20] If, on the other hand, m2 owns asset a2, its best course of action would be to make the "high" investment of $20. Because ownership means m2 can sell the input on the spot market (for $30), m2 will make the high investment. Ownership increases m2's threat point from $0 to $30, which makes the high investment worthwhile. (To be precise, m2's payoff would be $45: its $30 threat point plus $35, half of the bargaining surplus of $70, the bargaining range between its $30 threat point and m1's valuation of $100, minus m2's $20 investment; see Figure 3).[21] In short, ownership shifts m2's threat point upward, creating an incentive for an adaptive investment that increases social welfare.[22]

Figure 3 illustrates the effect of ownership on m1's threat point. In terms of this Figure, ownership increases m2's threat point, which opens a bargaining range between the parties. The gains from trade inherent when m2 is well-situated to adapt asset a2 for m1's purposes can then be realized.

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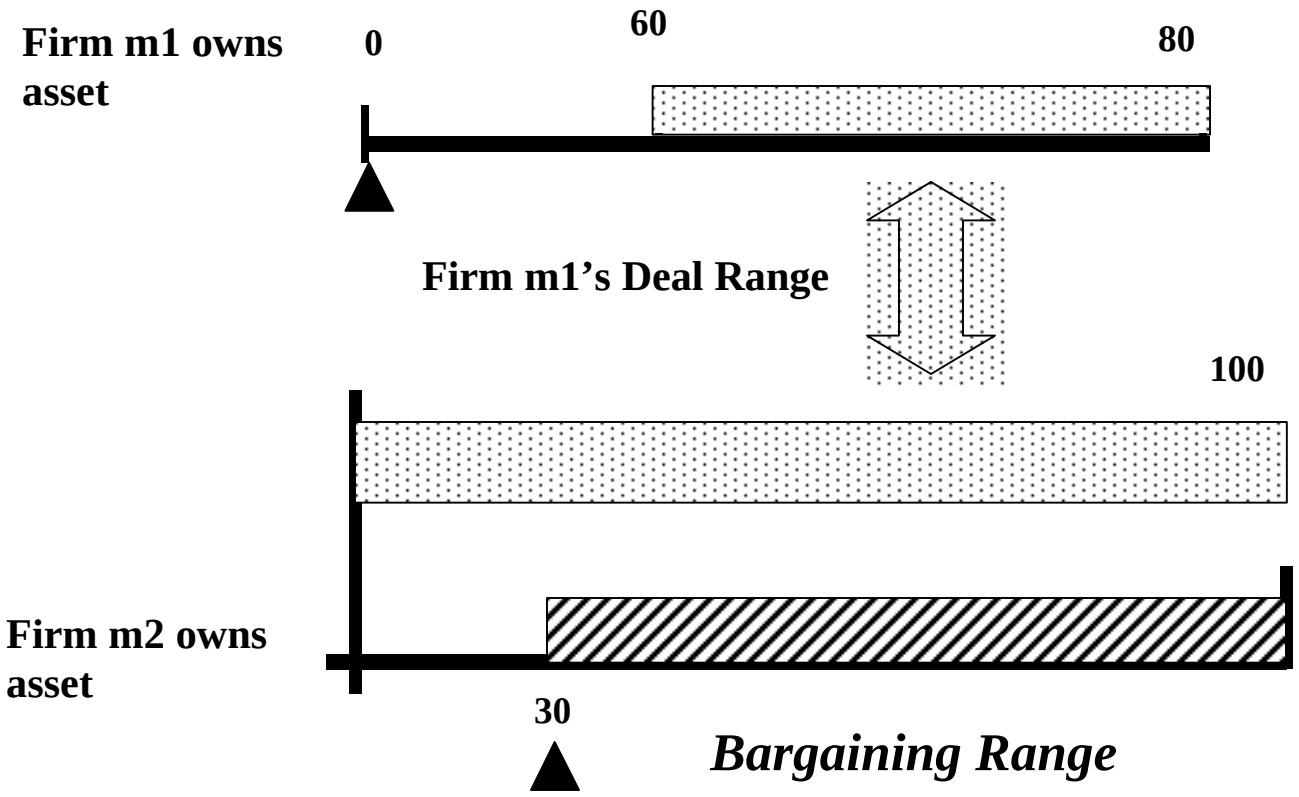
[20] Imagine a typical scenario: prior to purchasing, m1 asks for product specifications or a prototype of the input that m2 will supply. M2 must comply, so m1 can determine the quality of the input and also make sure it can be easily integrated into m1's end product. But if the input modified for m1's needs can be readily reverse engineered, m2's adaptive investment is at great risk. In legal terms, m2 would have to rely on trade secret protection for the input, which is much weaker than the formal property right protection afforded by a patent.

[21] If m2 makes the low investment, it will net only $40: its $10 threat point, plus half the bargaining surplus ($10 to $80, m1's valuation at the low investment, minus m2's $5 adaptive investment).

[22] As mentioned earlier, ownership is Coasean. The example in the text assumes that m2 owns a2 at the outset of the transaction. But even if m1 owns a2, m1 will realize that ownership in the hands of m2 is the only way m2 can be induced to make the first period investment leading to the jointly-profitable transaction at the second period; hence m1 will assign ownership of a2 to m2. Of course, m2 will have to pay for the assignment. The price would be $10, half the $20 in additional joint surplus created when m2 owns a2 versus when m1 owns a2 ($80 versus $60). (Thanks to Oliver Hart for pointing this out.) The question of what happens if m2 does not have access to the cash needed to buy a2 is addressed below in section 2.3.

Fig. 3 Ownership Moves the Threat Point (▲)



The Effect of the Absence of Property Rights

A simple example in the spirit of the GHM literature will illustrate the basic point. Unlike in the GHM literature, in this example asset a2 is not a physical asset such as a machine. It is instead an intangible production technique: a process or "recipe." Also unlike the usual GHM examples, the process is not protected by clear, well-respected property rights. We can therefore draw the m1-m2 transaction as follows:

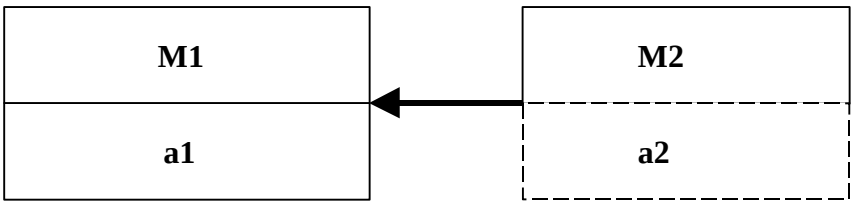


Figure 2

In Figure 2, asset a1, used in the production of the final product, is protected by conventional ownership rights, just as in the normal GHM models. But the story is different for a2.This asset is used to produce an input that will be used by m1 at T_1. But property rights in a2 are nonexistent or unclear, as the dotted lines around it are meant to signify.

The process that is asset a2 can be adapted so that the products it yields work particularly well in the assembly of end products. In fact, the process *must* be adapted to a buyer's needs, to some extent at least, for the products of the process to have any value at all. (If this assumption seems strong, see the next section for a discussion of the Genentech-Alkermes License Agreement, a good example of such a transaction.) For this reason, there is no spot market for the

output of a2 in its unmodified form.[23]

Realizing value from a2 thus requires an interchange of information between m2 and a prospective buyer such as m2. During the course of this exchange, both parties will learn a good deal about the production technology of the other firm. Thus it is a precondition for m2's adaptive investments that m1 will learn the details of m2's process. If there are no formal property rights available to m2, its only recourse is to try to protect process a2 as a trade secret via contract. In its agreement with m1, m2 will specify what information it (m2) considers secret and proprietary. M2 will elicit from m1 promises not to use or disclose the information during the course of the agreement, and to extend this agreement to m1's third party consultants, suppliers, and other third parties. There will be protracted negotiations over each term and the parties will try to foresee as many contingencies as possible. In the end, the agreement may or may not fully protect m2's asset, a2, from nondisclosure. Trade secret law, while useful, is "leaky" in many cases.

Notice that these assumptions render m2's situation a bit precarious. It must adapt its technology to the needs of its customers. Yet it risks the loss of de facto exclusivity when it does so. In a conventional GHM model, asset a2 is a physical asset, such as a machine. Ownership is equated, implicitly at least, with having the asset in one's possession. And of course possession by one party implies the exclusion of the other. This is why ownership of an asset has the effect it does: to raise the owner's return in the event of no trade with the other firm. But when a2 is an *intangible* asset, such as a technique or process, no such ironclad exclusivity is possible in the absence of property rights. Residual control rights in asset a2 cannot be assigned among the parties,[24] so asset ownership cannot be used to align incentives as in GHM models. Put another

[23] Because the output of asset a2 can be adapted for use by firms other than m1, a2 is not strictly complementary with a1 and therefore it does not follow that the situation calls for the integrated ownership of a1 and a2.

[24] The parties may try to transfer the equivalent of residual control rights in a2 by contract, but this will necessitate extra expenditures, in an attempt to re-create by contract the residual rights that ownership would have conferred. And because there is some limit to how many contingencies

way, in the absence of property rights, to deploy asset a2 is to risk losing exclusivity over it.

This does not necessarily mean that no one will have an incentive to develop a2 in the first place, however. Perhaps by integrating the product of a2 into its end product, m1 could appropriate enough of the cost of developing a2 to make it worthwhile. This is an example of the use of complementary assets as an "appropriability mechanism," a concept developed by David Teece (1986). Other scholars have advanced this theme further, arguing for example that a combination of appropriability conditions and technology factors determine which firms in a given industry are likely to generate innovations (von Hippel, 1988).[25] In the terms formulated by the appropriability literature, the viability of m2 as a separate firm may be in doubt. If so, m2's only options would be to join firm m1 as an employee or develop another asset.

Taking the first case, m1 (and hence society in general) may be worse off. M2 may have less of an incentive to develop the asset in the first place, and then to adapt it to m1's production technology. M1, as an employer, may not be able to duplicate the "high powered incentives" that come with arm's-length market transactions (Williamson, 1985). Consequently, m2 may not work as hard as an employee. Where this is so, m1 loses the value that m2 *would* have generated in gains from trade.

If we introduce property rights into the picture, m2 will behave differently. First, assuming

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the parties can write into the contract, it can never allocate full residual control. This notion, derived from the literature on incomplete contracting, explains in a novel way the well-known superiority of patent rights over trade secret law. Patent law, being a property rights regime, provides true residual control (i.e., a robust "right to exclude others," in the words of the statute, 35 U.S.C. § 154); while trade secret law, primarily a creature of contract, relies on the agreements of parties to spell out their respective rights, with no notion of a residual.

[25] Note that this literature takes the property rights in an industry as one of a number of fixed "background" conditions, and analyzes how firms develop appropriability strategies in light of these conditions. In this paper I shift attention to the strength of property rights as a variable that can be changed, with attendant effects on viable firm strategies.

that prior to T_0 m2 has not formed an independent firm, she will constitute herself as an independent firm to exploit asset a2. And second, she will in certain cases make the adaptive investments required to maximize the value of the asset's output to a particular customer, m1. The first effect is novel, from the perspective of the property rights literature, while the latter is familiar.

To understand the first effect, consider that the property right over a2 makes possible a market for the output of this asset. Given assumptions about the nature of the technology, property rights over a2 are a precondition for exchange. They allow the value of a2 to be realized in arm's-length transactions involving a2's output. Without property rights, to deploy an intangible asset is to risk losing exclusive control over it.

It is important to see that property rights enable m2 to negotiate with m1 at T_0, not only because a2 is protected against misappropriation by m1, but also because it is similarly protected in the event m2 is forced (by m1's refusal to trade at T_1) to deploy a2 for an alternative buyer. In GHM terms, property rights not only make it possible for m1 and m2 to bargain at T_0. They also create a spot market in the output of asset a2. True, this spot market is somewhat different from those in standard GHM models, due to the nature of intangible assets. M2 must adapt a2 at least somewhat for its output to be useful to a buyer. This is why property rights over a2 are important. Without them, the disclosure of a2 required prior to adapting it would create a risk of losing exclusive control over it. In this way property rights over process a2 provide a fallback in the event that pre-arranged trade with a specific buyer such as m1 does not take place.

Thus property rights in a2 create the preconditions for exchange. They also have the effect of inducing optimal adaptive investments on the part of m2. Once property rights over intangible assets are established, the standard GHM result goes through: relationship-specific investment that maximizes joint surplus. Property rights permit recourse to the spot market for the output of a2. This fallback option for a2's owner establishes threat points against which bargaining takes place at T_0. What follows is the familiar GHM result: the parties allocate ownership at T_0 so as to

encourage optimal adaptive investment and thereby maximize joint surplus at T_1. With property rights, in other words, the parties have something to allocate at the outset to bring their incentives into alignment.

In those cases where m2 is the party whose adaptive investments in a2 add the most value, the establishment of property rights is socially valuable. It allows m2 to establish itself as an independent firm. There is thus a link in this context between property rights and firm boundaries. And indeed, if a number of firms such as m2 come into existence in a particular industry, then the establishment of property rights will have had an impact on industry structure as well.

2.1 A Real-World Example

To give some real-world context, we will consider in some depth a representative collaboration in an IPR-intensive industry: a joint development agreement between Genentech, the largest biotechnology company in the world, and a very small firm specializing in sophisticated drug delivery technology, Alkermes, Inc.[26]

The basic structure of the Genentech-Alkermes deal follows the logic of the GHM literature. There are two stages to the transaction: (1) Alkermes adapts the drug delivery technology in which it specializes, called microencapsulation, to Genentech's successful therapeutic product, a genetically engineered form of the naturally-occurring protein called Human Growth Hormone (HGH); and (2) Alkermes manufactures the product for Genentech and

[26] License Agreement Between Alkermes Controlled Therapeutics, Inc. and Genentech, Inc., effective November 13, 1996, attached as Exhibit 10.3 to SEC Form 8-K, filed by Alkermes, Inc., on November 14, 1996, available on SEC EDGAR database at www.sec.gov/edaux/formlynx.htm (hereafter "Genentech-Alkermes License").

sells it at a pre-agreed price, with Genentech then marketing and distributing it.[27] This is a common deal structure in biotechnology, one which flows from firms' desire to do joint R&D but still control production if possible.

HGH is administered to patients who suffer from a deficiency in the production of growth hormone; the particular application that the parties developed in the context of the agreement involves pediatric growth hormone deficiency, i.e., it was aimed at children.

Alkermes is one of a number of firms working on advanced drug delivery techniques. Some are well known, such as the transdermal patches now common for delivery of nicotine and nitroglycerin. Others are more exotic. Alkermes, for instance, has developed a procedure for

[27] Alkermes-Genentech Agreement, § 6 ("Genentech agrees to pursue a diligent sales and marketing effort for a Licensed Product to be sold by Genentech relative to other products of similar commercial potential that are being sold and marketed by Genentech.") The structure of this and similar agreements in biotechnology is also consistent with recent additions to the GHM literature which stress the role of option contracts in promoting investment incentives where agents must invest in a project first before it is handed off to a principal for final marketing. *See* Georg Noldeke and Klaus M. Schmidt, "Sequential Investments and Options to Own," 29 Rand J. Econ. 633-653 (1998); Aaron S. Edlin and Benjamin H. Hermalin, "Contract Renegotiation and Agency Problems," Working Paper, Oct., 1998. Both papers posit models of principals who induce efficient investments on the part of agents by means of appropriately priced option contracts. While Noldeke and Schmidt emphasize only the initial price, and assume essentially no renegotiation of the option, Edlin and Hermalin show that even with renegotiation of the option, in one important case agents will still make efficient investments: when the agent's investment increases his or her threat point. This occurs when the investment raises the value of the agent's payoff in the event the deal with the principal does not go through. Arguably, this analysis applies in a general way to the Alkermes-Genentech License Agreement. There is a pre-agreed price for the sale of microencapsulated HGH in the Agreement (License Agreement § 5.1), and Genentech's broad termination right gives it in effect the power not to exercise the option (§ 9). But, consistent with the main theme of this paper, the real point is that Alkermes' payoff is secure only with legal rights over the microencapsulation production technology – i.e., a strong patent for it. Without exclusive ownership, Genentech can terminate and use Alkermes' technology to produce its own sustained release HGH. Thus my argument here is once again to relax a key assumption of this property rights-related literature. As Edlin and Hermalin state, "[H]ere . . . efficiency dictates that ownership (control) always be given to the principal in the end . . ." (1998: 4 n. 6). My topic is the effect of conferring or strengthening ownership rights in the first place, and the effect this has on the parties' ability to structure these sorts of transactions.

coating an active ingredient in very thin polymeric capsules. The capsules are made of material that breaks down over time in the human body. Unlike traditional encapsulation (e.g., the "thousands of tiny time capsules" of "Contac" cold medicine fame), Alkermes' technology yields much smaller capsules and can be used on ingredients that have traditionally fared poorly in encapsulated form.

It is important to recognize at the outset that there is no hard and fast reason why Genentech could not pursue advanced delivery systems itself. It is certainly no barrier that novel delivery vehicles require sophisticated manufacturing. Genentech has mastered very complex manufacturing problems relating to a number of its biotechnology products. Likewise, the high R&D intensity of the drug delivery business is no barrier; Genentech pursues R&D of unmatched depth and breadth in the biotechnology industry. And there is no legal or regulatory barrier keeping Genentech from this line of business. Clearly, this is a classic "make or buy" decision. And there is something about the capabilities of Alkermes, a small, independent firm, that makes it attractive for Genentech to buy from it.

Genentech is not alone. The Alkermes business model is to develop microencapsulated versions of highly successful drugs. This it does in close collaboration with the large drug firms that own the rights to the drugs: it has deals with Schering-Plough, Johnson and Johnson, and of course Genentech, among others. Drug firms enter into these deals to access Alkermes' proprietary delivery technology, which makes the drugs easier to take, and in some cases opens up new submarkets not available using conventional delivery techniques.[28]

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[28] *See, e.g.*, Mary Welch, "Extended Formulation Strong in Phase III Study, Genentech, Alkermes Report," BioWorld, Oct. 23, 1998,

"Both companies probably will start Nutropin Depot trials on adults at some point," [Richard] Pops [, CEO of Alkermes] said. "With adults, it's not a matter of trying to increase height, but there are some other manifestations of growth hormone deficiency ," he said. "A lot of adults don't take growth hormones because they don't want to deal with daily shots."

As the theory developed here would predict, Alkermes is quite "patent intensive." This is essential if it is to succeed as a business partner with large, skilled companies that are quite capable of learning about and then competing in the area of microencapsulation. This explains why Alkermes has numerous patents covering (1) its microencapsulation process; (2) novel polymers and preparations that make up the coatings; and (3) microencapsulated formulations of the drugs it delivers under its collaboration agreements.[29]

While all its patents serve a useful purpose, the third category is worth a closer look. Alkermes has several patents on microencapsulated versions of some of the best-selling therapeutic products in the biotechnology industry, Genentech's HGH and Schering-Plough's Alpha Interferon.[30] When one looks closely at the agreements governing Alkermes' research collaborations, one can see that Alkermes' ownership of these patents in particular demonstrates an imperfect but intriguing fit between the structure of biotechnology agreements in practice and the predictions of GHM theory.

Consider for example the Alkermes-Genentech License. It has the standard two-stage structure of most such deals: R&D by Alkermes, followed by manufacture and sale of product to

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[29] As of 1998, Alkermes had 35 U.S. patents, numerous foreign counterparts, and more on file. *See* Alkermes, Inc., SEC Form 10-K, filed March 31, 1998, available at www.sec.gov/edaux/formlynx.htm, at p. 19 ("Patents and Proprietary Rights").

[30] *See, e.g.*, Johnson et al., U.S. Patent 5,667,808, "Composition for Sustained Release of Human Growth Hormone," issued September 16, 1997 (assigned to Alkermes, Inc.); U.S. Patent #5,674,534, "Composition for Sustained Release of Non-Aggregated Erythropoietin," developed in conjunction with a collaboration with Johnson & Johnson, Inc. (see Licensing Agreement, Exhibit 10.2, Alkermes SEC Form 8-K, Nov. 14, 1996, available www.sec.gov/edaux/formlynx.htm. Similar patents have issued for microencapsulated Alpha interferon, which grew out of a collaboration with Schering-Plough Corporation. *See* Alkermes, Inc., SEC Form 10-K, filed March 31, 1998, available at www.sec.gov/edaux/formlynx.htm.

Genentech.[31] Interestingly – and predictably, from the viewpoint of GHM and incomplete contracting theory in general – Alkermes is required to make substantial investments in adapting its technology to Genentech's product and in creating the production process needed to manufacture it. This is evident from the License Agreement, which contemplates the creation of "Alkermes Knowhow," defined in § 2.1 as "data . . ., knowledge, discoveries, . . . specifications, . . . methods, processes, and techniques" during the course of the Agreement.[32] Notwithstanding this commitment, Genentech has a very broad right of unilateral termination: basically, at any time for any reason, prior to Alkermes' commencement of commercial manufacture; and upon six months notice after commercial production. And Genentech has broad power to decide whether Alkermes is living up to its obligation to produce commercial grade product that meets Genentech's standards.

There is clearly a great deal of risk in this arrangement for Alkermes. It could easily invest millions of dollars in the R&D and scale-up needed to meets Genentech's predicted demand, and then see the entire deal terminated with little recourse. The License is quite explicit in this respect (§ 4.3(A)):

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[31] The License Agreement has been so characterized in the trade press. *See* "Genentech, Inc.: When Put Comes to Call," BioVenture View, March 1, 1996 (emphasis added):

> [Genentech] has also recently signed *a research and development agreement* with Alkermes to get an injectable slow release form to market. Alkermes is to proceed through Phase I clinical trials with the formulation, which will then be *codeveloped* by Alkermes and Genentech.

[32] The Agreement provides for an up-front prepaid royalty and a small loan from Genentech, but does not characterize this as payment for development of the knowhow, it would be very hard to verify that particular funds were used to developed knowhow, or to evaluate the quality of the knowhow, in any event. As would be expected, Alkermes grants a license to Genentech for the use of this knowhow during the course of the agreement, but such information in rarely set down in "codified" form and hence is difficult to monitor or transfer. This aspect of the License Agreement does not survive termination, which means that Alkermes is free to use and adapt the knowhow it develops whether or not it sells product to Genentech.

> Alkermes shall be responsible for, and shall use its commercially reasonable efforts to, scale up the process for producing Licensed Product for both clinical and (unless Genentech manufactures commercial Licensed Product pursuant to Section 5) commercial requirements provided that Genentech supplies sufficient quantities of human growth hormone (at Genentech's expense) to enable Alkermes to do so. Exhibit C attached hereto sets forth the anticipated timeline, requirements and costs for scaling-up the manufacturing process for making Licensed Product for clinical and commercial use to treat pediatric [Growth Hormone Deficiency]. *Genentech shall not be responsible for any of Alkermes' capital cost of its facilities* except as otherwise set forth in Exhibit C or approved by the [joint development committee set up by the companies under the agreement].[33]

So what protection does Alkermes have? One important one is ownership of the assets that enable production of the microencapsulated drug that Genentech wants. While these assets do take on a tangible form, it is clear that Genentech could duplicate the production process if it wanted. (Indeed, it has the right to take over production if it deems Alkermes' efforts unsatisfactory, and it has world-class production facilities at its disposal with which to do so.)

What is left, in a word, is patents. Alkermes has now obtained two patents on the microencapsulated form of Genentech's HGH.[34] This means that Genentech cannot produce this

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[33] The Agreement on file with the SEC had these provisions redacted. It is very unlikely that these exceptions to the "no capital contribution" clause were significant, however, for two reasons. First, a large dollar value item would be unlikely to be relegated to an Appendix of the Agreement; it would likely have been heavily negotiated and hence incorporated into the body of the contract. Second, a large contribution by Genentech would have had to be recognized somewhere on Alkermes' books, and reported as "material" under the Securities laws. No such item appears in the associated financial statements, however.

[34] *See* Alkermes Press Release, September 26, 1996, available at www.alkermes.com.

> "Alkermes is building an extensive portfolio of patents and patent applications relating to its ProLease and Medisorb® drug delivery systems," said Richard F. Pops,

formulation of the drug without coming to agreement with Alkermes. And this, ultimately, is Alkermes' real security under the collaboration agreement. The point is obviously not lost on Genentech, either: the collaboration agreement explicitly permits Alkermes to retain ownership of patents it develops on its own, even those relating to Genentech's technology. While *jointly developed* inventions are jointly owned under the agreement, these are limited to cases where one or more of the inventors listed on the patent work for each of the firms. Since the collaboration began, Alkermes has obtained two such patents so far relating to HGH; it is listed as the sole owner of each, with no assignment or license in favor of Genentech shown to date.

What role do these patents play in the transaction? In general they provide a fallback for Alkermes in the event that Genentech does not continue with the agreement. While these patents show that Alkermes' microencapsulation technology is *optimized* for Genentech's specific HGH, they also reveal that Alkermes does not strictly require Genentech's HGH to commercialize its own microencapsulated version of the drug.[35] This is because while Genentech's recombinant version of HGH is without doubt the largest selling formulation of the drug, it is not the only form. HGH, after all, is a naturally occurring hormone. Alkermes could, under its own patents, apply its microencapsulation technology to the publicly-available, naturally-occurring version of the hormone.[36] The License Agreement prevents Genentech from using the Alkermes technology after the Agreement is terminated.[37] Thus if Alkermes introduces a non-Genentech

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Chief Executive Officer of Alkermes. "This [HGH] patent is an important component of the intellectual property developed in our ProLease human growth hormone program."

[35] *See* Johnson, et al., U.S. Patent 5,654,010, "Composition for Sustained Release of Human Growth Hormone," issued Aug. 5, 1997 (assigned to Alkermes, Inc.), at Example 1: "Human growth hormone (hGH), whose DNA sequence is described in U.S. Pat. No. 4,898,830, issued to Goeddel et al. [and assigned to Genentech] was used in this Example."

[36] *See* id., references to "biologically active hGH," passim; and id., Examples 2-7 (no mention of specific hGH used, so not limited to Genentech's recombinant version).

[37] License Agreement, §§ 1.3 (Definition of "Alkermes Patents," which includes after-acquired patents relating to protein microencapsulation); 2.1(A) (Grant of License Right to Genentech); and 9 (Termination: grant of license does not survive termination).

microencapsulated HGH product, Alkermes will be the only seller on the market with such a product. This is clearly not as profitable as selling Genentech's version, which dominates the market because of its superior functionality.[38] (If it were as profitable, there would be no gains from trade and the parties would never have made the deal in the first place.) Besides lower functionality, Alkermes' HGH product would have to gain FDA approval to be marketed. This would add significant costs as well. Still, by owning the patent to microencapsulation of HGH, selling its own non-recombinant version of HGH *is* an option for Alkermes.

Alkermes's HGH microencapsulation patents are thus quite analogous to the productive assets described in the GHM models. Owning these patents gives Alkermes a much more lucrative "outside option," which it presumably will use in the event Genentech does not follow through on the initial agreement and refuses to buy the specially formulated HGH Alkermes makes under the contract. Ownership of its patents permits Alkermes to reap at least some rewards for investing in adapting its technology to Genentech's product. The provision of the Alkermes-Genentech Agreement allowing Alkermes to take title to its own HGH-related inventions even states: "This Section . . . shall survive the termination or expiration of this Agreement."

One might go so far as to posit that Genentech understood as much, and allowed Alkermes to own these patents as a way to induce Alkermes to invest in adapting its technology to HGH.[39]

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[38] Genentech's sales of HGH-based products now exceed $50 million annually. *See* Mary Welch, "Extended Formulation Strong in Phase III Study, Genentech, Alkermes Report," BioWorld, Oct. 23, 1998.

[39] The Alkermes-Genentech Agreement (at § 10.1) states:

> The Parties recognize that either Party may independently and separately make inventions during the course of this Agreement relating to human growth hormone, delivery systems for human growth hormone, PLGA encapsulation of proteins or otherwise related to the scope of this Agreement . . . .

2.2 Limitations of the GHM Models

Unquestionably the GHM models are somewhat narrow in scope, and not by their own terms robust to divergent assumptions. The numerical example given earlier, for example, is quite dependent on the choice of specific values. As the example shows, GHM models assume just a certain degree of specificity in the investment by m2. This plays out in the model as follows. The investment by m2 adds greatly to m1's marginal valuation of the input, but also moderately increases its spot market value. Thus the models turn on a crucial fulcrum: the relationship between the respective returns on investment for firm-specific (i.e., m2-m1) and spot market sales.

In addition, GHM models drop the assumption of incontractibility at a convenient moment. Notice that the parties' ex ante agreement to split the surplus created by the exchange at T_1 is assumed to be fully enforceable. There is no occasion for opportunism in this exchange, in other words.[40] It is as if Williamson's (1985) "fundamental transformation" never takes place. Indeed, such an assumption seems quite contrary to the bulk of the "make or buy" literature.

The resolution of these shortcomings is ongoing in the economics literature. Undoubtedly "second generation" extensions of GHM theory will strive to overcome them. Recent discussions of option contracts[41] as a substitute for ownership, in particular, will pose a challenge to the basic premises of the property rights approach.

Yet even the early GHM models reveal an intuition that is both powerful and, in a general sense, accurate. Behind the tightly-strung assumptions of the specific GHM models is the basic

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[40] This is related to the main ppoint of Edlin and Hermalin (1998).

[41] See, e.g., Noldeke & Schmidt (1998), who demonstrate that contingent ownership of one firm by another can induce efficient sequential investment under many of the same assumptions of GHM models.

proposition that "ownership" – meaning property rights – matters. It matters to commercial transactors, who rely on "off the shelf" property rights to structure economic exchange. It matters to firms contemplating such transactions (as discussed later in section 3), who spend significant sums on acquiring IPRs, at least in part with an eye toward deploying them in future exchanges. It matters to lawyers, who rely on what GHM would call residual rights to backstop and augment contract terms. It matters (or ought to) to courts and legislators, who should seek to understand the broad commercial implications of re-specifying property rights – e.g., the significant strengthening of IPRs in recent years. And finally, it matters to courts and legal observers, who consistently point up the fundamental distinction between contracting and transferring property rights.

In the end, what is useful and valuable in the GHM literature is not so much the specific answers it gives as the questions it asks in the first place: what is the relationship between property rights and contracts? How does the availability of property rights affect what might be called the "feasible contract set"? How can a change in the specification of property rights[42] affect the possibility of arm's-length transactions, the viability of independent firms, and even specialization? These are the questions that interest me, and at least GHM models address them.

2.3 Resource Constraints

Before moving on to explore the empirical evidence, it is important to examine what happens when we eliminate a key assumption from the GHM literature. In GHM, resource constraints do not exist. That is, both M1 and M2 have enough resources that they are not affected by issues of relative bargaining power and the like. In the most important real-world case that follows the logic of the m1-m2 exchange, however, recent empirical research shows

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[42] Note that in this respect, the most thoroughly theorized literature on economic exchange and governance, Williamson's transaction cost economics, typically chooses to "hold[] these background conditions [including property rights] constant." Williamson (1996: 222).

convincingly that this is not accurate. Josh Lerner and I (Lerner and Merges, 1998) analyzed 200 patent licensing agreements in the biotechnology industry, entered into between 1980 and 1995. These agreements were typical for this industry: a small-firm research unit licensed technology to a large company, usually a pharmaceutical firm. We broke down ownership issues into a series of 25 detailed control rights that were often assigned in these agreements, ranging from patent ownership to manufacturing rights to marketing territories. We concluded that the best predictor of the number of control rights allocated to the biotechnology firm was *not*, as the GHM model might be read to predict, the importance of the biotechnology firm's investment (as proxied by the stage of technology development and sophistication of the biotechnology firm's existing technology base). Instead, the best predictor was the financial status of the biotechnology firm at the time the agreement was signed (Lerner and Merges, 1998: 147). When that firm's outside financing prospects were bright – i.e., when the initial public offering and venture capital investment markets were favorable – the biotechnology firm retained more control rights. When the financial situation was relatively bleak, the pharmaceutical company/licensee received more control rights.

These results are consistent with one finding of a theoretical study by Aghion and Tirole (1994). These authors incorporated a "wealth constraint" into a GHM-type model, and demonstrated that the efficient allocation of property rights as between a research unit and a "customer" (i.e., licensee) would not always take place. They found that even though research unit ownership of an "innovation" created favorable incentives, the parties might not be able to arrange things this way. A cash-short research unit can not prospectively compensate the licensee for giving up the licensee's ownership claim to the asset. The result is similar to the analysis I presented earlier in describing the effects of an absence of ownership rights. In some cases, most notably when the prospective licensee has default ownership rights, a joint profit-maximizing allocation will not take place; social gains will be left "on the table."

To put these findings in perspective, two comments are in order. First, the Lerner and Merges study aggregates a number of "control rights," to gain an overall sense of the allocation of

duties and benefits in biotechnology licensing agreements. Many of these rights are only loosely related to the notion of "residual rights" in the GHM literature. A closer look at the subset of "control rights" that fairly approximate residual (ownership) claims tells a different story. In only 6% of the surveyed agreements did a biotechnology firm assign ownership over its "core technology" to the licensee (Lerner and Merges, 1998: 143). Core technology is defined as the technological assets belonging to the biotechnology firm prior to the licensing agreement. This means that the biotechnology firm retained ownership over the assets most important to it. These assets are undoubtedly crucial to the biotechnology firm's ability to make profits outside the specific relationship with the licensee.[43] Allocation of ownership rights over core technologies is therefore consistent with the GHM framework. This arrangement increases the biotechnology firm's threat point in the transaction over the input, and therefore induces it to invest appropriately in unobservable qualities that will enhance the input in the hands of the licensee firm.

Second, equity investments by the licensee can, at least to some extent, mitigate the bad effects of the research firm's inadequate financial resources. The thinking would be as follows: The investment means that the licensee should be concerned not only about the short-term profit that will occur when the T_1 exchange takes place, i.e., the purchase of the input made using the asset in question; but also about the long-term prospects of the research firm. Equity investments may align incentives, in other words, when efficient allocation of asset ownership is impossible due to capital constraints. In this connection it is interesting to note that many biotechnology licensing agreements involve at least some equity arrangements (Lerner and Merges, 1998: 143).

[43] The licensing firm, however, very frequently retains at least a partial ownership claim over any patents that *result from* the collaboration. Lerner and Merges (1998: 143) (72% of agreements provide for at least partial ownership of resulting patents by licensee firm). This is not inconsistent with a GHM-type story. If these patents are viewed as (part of) the output from the collaboration, rather than as productive assets (i.e., a1 and a2) in their own right, this provision makes sense. It amounts to no more than a stipulation that, in effect, the licensee can use the input supplied under the agreement without fear of patent infringement liability should the agreement lapse or be terminated in the future.

For example, 51% of the licensing agreements studied provided for direct equity purchase at the time of the agreement; and 21% gave the licensee at least one seat on the biotechnology company's board of directors.

Thus in the final analysis the capital constraint modeled by Aghion and Tirole and confirmed by Lerner and Merges does not appear to fundamentally undercut the basic predictions of the GHM framework.

3. Empirical Backing

The ideas sketched here are related to the notion of appropriability as espoused by David Teece (1986) and others (e.g., Gemser and Wijnberg, 1995). Teece categorizes various "appropriability regimes," conditions that govern how a firm can recoup R&D expenses. Where property rights are weak, Teece observes, firms may respond with a number of strategies. They can, for example, acquire complementary assets that may become specific to a product technology **C** for example, manufacturing know-how, distribution systems, or support capabilities. Ownership of these assets thus serves as an Aappropriability mechanism@ that stands as an alternative to strong intellectual property rights.

From this perspective, an endogenous shift toward stronger property rights changes the appropriability calculus. Appropriability strategies involving the acquisition of complementary assets might be abandoned in favor of reliance on property rights. Specialization might displace integration. The need for coordination between different stages of the production process might be addressed by contract in the presence of strong property rights. Of course, all of these effects operate at the margin. Other considerations may still dwarf them. But to the extent that stronger property rights open up specialization strategies not available in the earlier appropriability regime, we would predict that it will usher in organizational experimentation and diversification.

In terms of the GHM framework, the effects of stronger property rights should not differ in principle from the effect of making property rights available in the first place. As with the introduction of property rights described earlier, stronger rights will, under some circumstances, foster more transactions between M1 and M2. In a fair number of cases, the bargaining surplus that M2 sought to capture can now be captured. With secure ownership of a2, M2 can effectively exclude M1 from use of this asset. Following GHM, this means that, all other things equal, M2 can now appropriate more of its relationship-specific investments in the T_1 transaction. This in turn means that M2 will *make* the surplus-creating investments in the first place, when conditions warrant. Thus, as in the original GHM models, the ultimate effect is to show how changes in the ownership structure of assets stimulate investments in relationship-specific skills. The new twist here is to introduce stronger rights as a separate variable, in addition to simple ownership of the assets. The conclusion follows logically that, where rights had been weaker before, a policy shift toward stronger rights can usher in the conditions for application of the conventional GHM dynamic.[44]

The remainder of this section details more rigorous empirical data bearing on the issue of stronger property rights.

Anand and Khanna (1997), in a study of 1612 licensing agreements, found that weak IPRs are associated with a lower incidence of licensing activity, especially with respect to Aprospective@ (to-be-developed) technologies. Weak IPRs also correlate with a higher incidence of transfers to related parties. Their analysis is based on a large database of strategic alliances, defined as licensing transactions, joint ventures, or other. Alliances are categorized by standard industry classification (SIC) codes. The key finding of the study is that in industries where IPRs are important,[45] licensing, as a percentage of all alliances, is much more frequent than in other

[44] Again, all other things equal. In some cases the creation of property rights, or strengthening existing rights, will not be enough to overcome opportunism or hold-up risks. *Cf.* Lerner and Merges (1998) (bargaining power in licensing transactions).

[45] Numerous studies document differences in the strength of intellectual property

industries. In the IP-intensive chemical-related industries, approximately 1/3 of the alliances are licenses. On the other hand, licensing constitutes only 18% and 24%, respectively, of the alliances in computers and electronics. (Anand and Khanna, 1997: 17). Thus the import of Anand and Khanna=s findings: a higher incidence of licensing correlates with stronger intellectual property protection.

These findings give substantial support to the theory of this paper. The stronger property rights available in the chemical industries support a higher volume of transactions, because they clarify ownership of IPR-based assets. With less risk of opportunism on the part of licensees, owners of patents in these industries are more likely to license them.[46]

Another interesting finding of Anand and Khanna (1997: 16-23) is that significant transfers of technology take place even in industries where IPRs are weak. The nature of the transactions differ, however. Firms in industries characterized by weak rights are more likely to engage in non-licensing alliances (joint ventures, etc.); to deal with firms they have dealt with before; and to cross-license. They are also less likely to contract regarding to-be-developed technology.

Thus where property rights are less clear, the data suggest a resort to alternative appropriability mechanisms. Instead of straight arm=s-length transfer, firms prefer (1) joint ventures and other alliance forms, which presumably permit closer monitoring (and thus have partial hierarchy attributes, i.e., qualify as Aquasi-firms@); and (2) licenses to entities with whom

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protection across various industries. In particular, patents are known to be most effective in chemical industries. They are widely thought significantly less effective in computers, electronics, and related fields (Merges and Nelson, 1990, citing Levin et. al. 1986).

[46] *See also* Shan and Song (1997: 267):

> [F]oreign equity investment is drawn to American biotechnology firms with high levels of patent activity. We suggest that, in the biotechnology industry, foreign direct investment in the form of equity participation can be an efficient vehicle for tapping into country-specific, firm-embodied technological advantages.

they have had past relationships **C** again, adding the dimension of reputation, trust, and a (loose) form of Arelational@ (contract-based) quasi-integration. In terms of the model stated earlier in this paper, these factors represent efforts by the firms to substitute some form of organization-based (hierarchical) coordination for the straight market coordination achieved through asset ownership in the model. Presumably, some of the gains from trade may be dissipated in creating and administering these structures. (Admittedly, the interactions encouraged may *create* value in some other cases.) Where this is true, they represent less efficient solutions to the incomplete contracting problem solved by property right specification in the earlier model. Ultimately, this only makes a difference if there are cases where the transaction costs of establishing property rights are lower than these administrative costs. While this is not of concern to Anand and Khanna, who take appropriability (the strength and clarity of the rights) as given, it is relevant to the discussion in section 4 below.

These findings are all drawn from data gathered in the 1990-1993 time period. So while they demonstrate the effects of *relatively* weaker IPRs on alliance structures in various industries, they do not address the change in the overall incidence of arm=s-length contracting that involves an IPR component. They do, however, provide some support for the widespread anecdotal indications that the gross volume of these transactions continues to increase; they show, for example, that licensing transactions increased in their database from 360 in 1990 to 427 in 1993. This is consistent with other data on alliances (Lerner and Merges, 1998: 129, Table II).

All available sources indicate that even the weak-IPR licensing transactions studied by Anand and Khanna have increased remarkably in number in the past ten or fifteen years (Zeckhauser, 1996 reviews the literature). The theory of this paper **C** which is consistent with the relationship set forth in Anand and Khanna **C** is that increases in the clarity and reliability of IPRs have led to an increase in the number of technology exchanges of all forms, licensing and non-licensing alike. Indeed, the argument in this paper may be seen as an extension of Anand and Khanna=s: whereas they note the differential impact of stronger IPRs on industries in the 1990s, I argue that generally more enforceable IPRs began to produce the same general pro-transaction

influence at an earlier time. Just as they observe the effect of stronger rights *among current industries*, I theorize the same effect *on all industries over time*.

The data gathered by Anand and Khanna contain one more important point. These authors state (1997: 21) that

> the size distribution of firms varies substantially across industries. . . . [T]he median size of firms involved in licensing deals in Chemicals is lower than the 25th size percentile in Computers, which is comparable to that in Electronics. . . . [T]he differences at the 3-digit SIC level are even more striking: the median firm size in SIC 357 and 367 (Computers and Semiconductors) exceeds the 75th percentile in Chemicals. Thus, while many firms in Chemicals are small and specialize in research, a large fraction of innovations in other industries occur within larger firms . . . .

The data thus confirm an observation made earlier, based on "armchair" empiricism: that stronger IPRs lead to the entry of small firms that specialize in R&D (Merges, 1995). In addition, it may point the way toward modifications of conventional economic theory and policy in the area of property rights. This is the subject of section 5, below.

The Anand and Khanna findings receive independent verification in the case of chemicals. In a recent historical survey of patents in the chemical industry, Arora (1997: 391) states: "The increased importance of technology licensing is closely related to the emergence of a class of specialized process design and engineering firms that have played an important role in the development and diffusion of process innovations." The same may be true of so-called "fabless" microprocessor firms, which sell designs and do not produce any chips at all.

Arora=s observation does more than lend support to the Anand and Khanna data. It also dismisses the notion **C** in the chemical case at least **C** that increased IPR licensing is occurring only because property rights have proliferated. Arora documents the role that patent-intensive

entrants have played in *developing* technology, rather than simply generating rent-seeking property rights. This is reassuring: on their own, the Anand and Khanna data do not necessarily insure that licensing is correlated to technological advance. A related paper by Kortum and Lerner (1997) lends more credence still: it finds that increased patenting activity in the 1980s and 1990s is due primarily to the pace of innovation, prompted by reforms in research management techniques. The authors thus reject the conventional view that patenting increased solely in response to the founding of the court that hears patent cases, the Federal Circuit Court of Appeals, in 1982.[47]

Even so, it is quite clear that firms will develop licensing strategies whether a license represents tribute for useful information or simply payment of a holdup fee. Indeed, one way of viewing the requirements of patentability is that they stand as a bar to the use of patents merely for rent-seeking purposes. By requiring that an invention be novel, useful, nonobvious, and adequately explained to the art, the law strives to prevent patents from becoming sterile, non-welfare increasing monetary transfers (Merges, 1988; 1997c). The point here is that *in the aggregate* the literature so far does not support the view that patents serve primarily the rent-seeking or holdup function. (But see the conclusion for a cautionary note.) Hence the higher licensing volume noted by Anand and Khanna is consistent with the story of this paper: real innovation by independent firms, transferred via arm=s-length contracts.

3.1 Case Study: Outsourcing in Chemical and Pharmaceutical Production

[47] Crow et al.=s (1998) more specialized study of patent licensing by research universities concluded that increased patenting did not unequivocally result in greater new information flows. In many cases, these authors point out, a technology would have been picked up by industry without a patent simply by scanning the scientific literature. Of course, this non-patent technology transfer mechanism relies on public funding of science. As the authors point out, university patenting has come to (partially) replace government science funding **C** becoming, in effect, a tax on the consumers of university research.

The Alkermes-Genentech example in section 2 used the GHM framework to explain the terms of one R&D/supply relationship in the biotechnology industry. To get a more general sense of how property rights contribute to the market for inputs, and how the availability of these markets may encourage creation of independent, specialized firms, we will now consider the emergence of a transaction-intensive sector in a different industry: outsourcing of "fine" chemical intermediate production.[48] We will examine the role of property rights – in this area, patents – in structuring R&D-intensive supply relationships. And we will try to relate the availability and deployment of these property rights to the emergence of firms that specialize in manufacture of intermediate products.

Recent years have seen very rapid growth in this industry. In the past, chemical and pharmaceutical firms did very little outsourcing at the production stage. They were until recently classic examples of vertically integrated production. Now, however, the industry trade press describes significant growth in vertical supply transactions, part of a general trend toward the outsourcing of research, production, and clinical trials (The Economist, 1998; Chemical Business

[48] Other industries show the same relationship between outsourcing and patents. *See* Rose (1997: C9):

> Today, Johnson Controls is one of the biggest and most sophisticated beneficiaries of automotive outsourcing in the world. The Milwaukee-based company's automotive sales are headed for $7 billion this year, up from about $650 million in 1986. Johnson Controls wins more patents for interior auto designs than any of the Big Three car makers, [and] boasts six straight years of higher earnings . . . .

Moore (1996):

> Johnson Industries, an older and larger contract furniture company in Elgin with annual sales of $10 million, has gone a step further. It outsources even the manufacturing of its patented product line, which includes laminated tables. ARather than have a manufacturing facility, we have relationships with vendors that specialize and each do one thing very well,@ says President Ron Schram.

NewsBase, 1997; Chemical Market Reporter, 1997).[49] A recent overview of trends in pharmaceuticals shows the rapid rise of outsourcing as a percentage of R&D expenditures. Roughly 18% of pharmaceutical R&D funds goes to outsourcing now.[50] And some of the most talked-about firms in the outsourcing industry have acquired production facilities form established pharmaceutical firms, thus getting a helping hand from customers in the creation of an independent outsourcing sector. According to Gain (1997):

> Fine chemicals maker Catalytica's (Mountain View, CA) purchase of Glaxo Wellcome's plant at Greenville, NC . . . tied to contracts worth $800 million, was a landmark in the ongoing effort by fine chemical companies to persuade pharmaceutical firms to outsource manufacturing. Similar to Lonza's takeover of a SmithKline Beecham unit in 1992 . . ., Catalytica's coup signals that more fine and custom chemical makers are hitting home with their arguments of their ability to help pharmaceutical makers get their new products to market faster and lower their costs. . . .
>
> While most major drug firms continue to keep key elements of their development processes in-house, they are increasingly ready to consider outside manufacture for other components of their operations. . . . "[A] contract manufacturer might be more efficient than we are internally" and, therefore, deserve consideration . . . . During the past three to

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[49] *See also* Van Arnum (1997):

> Virtual companies, the ultimate "lean and mean" approach to doing business are finding a home in the pharmaceutical industry. Typically retaining ownership of intellectual property and sales and marketing functions, a virtual company contracts out all other business activities. This is a plus for third-party providers, such as small-scale custom manufacturers, who are filling the holes in drug development. For pharma and fine chemical players, excess pharmaceutical manufacturing capacity and market pressure to develop new chemical entities is laying the groundwork for a new way of doing business **C** the virtual company. Kurt Eastman, president of Innotech, a Newtown, Conn.-based consultancy, says a Avirtual company typically will retain ownership of intellectual property and outsource those functions which it considers non-essential to drug development.@

[50] The Economist (1998: Survey p. 16).

> four years Merck has doubled the number of intermediates it outsources, [a Merck official] says. “Last year alone we saw a 20%-30% increase”. . . .
>
> Outsourcing is now fully incorporated in the manufacturing evaluation process at Eli Lilly (Indianapolis). “The manufacturing capabilities available in-house and out-of-house are given equal weight when assessing the development strategies of new drugs,” says [a] sourcing manager/specialty chemicals. [Economic considerations often] . . . discourage[] building new capacity and encourages outsourcing.

Outsourcing firms are a nexus for the development of chemical and pharmaceutical manufacturing technologies – technologies often covered by patents. Even firms that prefer in-house manufacturing recognize this (Gain, 1997). As the GHM-based model predicts, property rights play an important role in this industry. According to the trade press, in a story about small firms specializing in optically pure or “chiral”[51] compounds:

> Patent developments are influencing the business strategies of custom manufacturers. Against the background of a regulatory climate favoring resolution of chiral compounds, custom manufacturers are seeking patent protection for novel processes and optically pure compounds. . . . The hottest area for the development and patenting of chemicals is for chiral compounds. . . . With many leading pharmaceuticals being chirals, custom manufacturers with expertise in asymmetric synthesis are benefiting. The regulatory climate [favoring purer production with chiral technology], combined with chirals' potential greater efficacy as therapeutics, are driving the rush to patent catalytic agents, processes, and the isolated enantiomer [versions of promising drugs]. . . . Industry analysts

[51] Briefly, many molecules can exist in two mirror-image forms; they are said to be Achiral.@ The majority of biomolecules occurring in the human body exist in only one of the two possible forms. Because the wrong chiral form can be ineffective or harmful (as in the case of the drug thalidomide), sophisticated catalysts are required to ensure that the manufacturing process for a pharmaceutical product yields only the desired form of the molecule. *See generally* Ball (1994: 77-78).

agree that process development is shaped by protection of intellectual property and costs.[52]

The prevalence of this trend is confirmed by an informal survey of issued patents. Four outsource-manufacturing firms are mentioned in the Chemical Market Reporter (1997) source, for example: Catalytica, Inc.; Lonza Corp.; ChemDesign, Inc.; and SepraChem, Inc. These firms have generated an impressive list of 86 patents just since 1995. The vast majority of these patents are either process patents[53] or patents on specific catalysts used as intermediates in chemical and pharmaceutical manufacturing.[54] And it is clear that firms believe their proprietary process technologies are a major selling point for the outsourcing industry.[55]

Most of the companies specializing in chiral compounds, and in fine chemical outsourcing

[52] Rose-Maniace, 1997. *See also* Chemical Market Reporter (1997) (ATechnology is the differentiator" for makers of fine chemicals, according to an official of ChiroTech, a U.K.-based contract researcher and manufacturer; this firm for example Aoffers commercial quantities of S-naproxen, via a proprietary . . . bioresolution process.@).

[53] *See, e.g.* U.S. Patent 5,684,157, AProcess for the preparation of optionally 2-substituted 5-chloroimidazole-4-carbaldehydes,@ issued Nov. 4, 1997, and assigned to Lonza, Inc.; U.S. Patent 5,446,102, AOlefin metathesis catalysts for degelling polymerization,@ issued Aug. 29, 1995, assigned to Catalytica Pharmaceuticals, Inc.; U.S. Patent 5,658,796, AOptical resolution of alkyl chroman-2-carboxylates,@ issued Aug. 19, 1997, assigned to SepraChem, Inc. (AA process for resolving racemic alkyl 1,4-benzodioxan-2-carboxylates useful as intermediates in the synthesis of optically pure pharmaceutical compounds such as (S)-doxazosin is disclosed.@)

[54] *See, e.g.* U.S. Patent 5,641,726, AQuaternary ammonium carboxylate and borate compositions and preparation thereof,@ issued Jun. 24, 1997, and assigned to Lonza, Inc.

[55] Gain (1997) (quoting Catalytica executive who claims the firm can make drugs for customer faster and cheaper “with the aid of several patented development processes”). *See also* ChiRex, Inc. homepage (http://www.chirex.com) (“Chirex . . . serv[es] the outsourcing needs of the pharmaceutical industry . . . . [and] holds 54 patents and patent applications in the field of chiral chemistry.”).

in general, must maintain a close working relationship with their customers.[56] This is necessary to integrate the intermediate product sold by the input supplier into the overall manufacturing process of the large pharmaceutical client. Most of the transactions are structured as supply agreements, with the chiral supplier firm's compensation coming only when it sells final intermediate product to the customer.[57] As with the Alkermes-Genentech deal, then, we see the similarity to the transactions described in the GHM literature: a first stage, where the supplier invests substantially in adapting its proprietary technology to the needs of a customer; and the second stage, where intermediate products are sold. As the GHM literature predicts, property rights appear to play an important role in these transactions. The Supply Agreements I have reviewed often include a license of the *customer's* technology to the supplier firm.[58] But the supplier firm does not assign its patents to the customer, and indeed there is usually not even a *license* from the supplier to the customer. And the supplier is free to build on its proprietary

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[56] *See, e.g.*, Catalytica, Inc., SEC Form 10-K, October, 1998, available on SEC EDGAR database at www.sec.gov/edaux/formlynx.htm, at p. 4:

> Fine chemicals are usually produced to specification in lower volumes using complex manufacturing processes and must satisfy well-defined chemical specifications, which generally results in a closer relationship between the fine chemical producer and the customer. Fine chemicals typically are sold for higher prices than other chemicals. Rapid response to potential customers, reliability of product supply and quality are important competitive factors. . . . A key component of Fine Chemicals' strategy is to become involved with its customers early in the design of the drug manufacturing process. Fine Chemicals believes that its technology and expertise enables it to develop efficient manufacturing processes at the research and clinical samples stage and successfully scale-up such processes for the manufacture of commercial volumes. These broad capabilities, coupled with its research, pilot and manufacturing facilities, should enable it to develop close relationships with its customers by becoming an integral part of their drug development process and a key preferred supplier of the customer's commercial fine chemical requirements.

[57] *See* Supply Agreement between Chirex, Ltd. And Cell Therapeutics, Inc., Exhibit 10.11, Chirex, Ltd., SEC Form 10K-405, filed November 14, 1998, available SEC EDGAR database; Supply Agreement between Glaxo Operations (UK) Ltd. And Chirex, Ltd., Chirex, Ltd. SEC FORM 8-K, filed Sept. 23, 1997, Exhibit 10.13, available SEC EDGAR database.

[58] *See* id., Supply Agreement at § 12.3, at p. 15.

technology in the course of performing the supply contract.[59] Again, as per GHM, ownership of the productive assets gives the intermediate supply firm a reasonable fallback position in the event that future trades with the customer firm do not come through. And it is quite clear from the financial disclosure documents of chiral suppliers that they well understand the risks of opportunism in this business context.[60]

In one respect, conditions in this industry might appear at odds with the basic structure of the GHM model. The point of the GHM models is to show how asset ownership creates incentives for *firm-specific* investment. In chemical production outsourcing firms, investments appear to yield benefits from multiple trading partners, and it is difficult to find evidence of substantial firm-specific investments of the type central to the GHM paradigm.

Even under the GHM model, however, the M2 firm can usually expect some returns from trading with input buyers other than M1. Thus the mere fact that investments enable trade with

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[59] *See* id., at § 12.4.2, p. 16:

> [For all improvements,] if discovered, or learned of, by Chirex and not being specific to the Products, Chirex shall have the right to such improvements in relation to all products other than Products [covered by the Supple Agreement].

The Agreement does not define what it would mean for an improvement to be "specific" to Glaxo's products, but it is very likely that Chirex learns much in the course of each supply relationship that it can use in its others. As per GHM theory, it is Chirex's ownership of its own production technology – the patents to its chiral intermediates and ways to produce them – that encourages Chirex to invest in the Glaxo-specific know-how required to adapt Chirex technology to Glaxo's products.

[60] *See, e.g.*, Chirex, Inc., 1998 Form 10-K405, *supra*, at 8 (emphasis added):

> The Company's current competitors include Alusuisse-Lonza Holdings AG, DSM Andeno B.V. and Laporte PLC. *In addition, the Company competes with major pharmaceutical manufacturers (including a number of the Company's customers) who develop their own process technologies and manufacture fine chemicals and pharmaceutical intermediates in-house.*

other firms does not take chemical outsourcing outside the GHM logic. In addition, it would make sense for an outsourcing firm to adapt some of its production resources to a particular customer firm, if the returns were large enough. Indeed, both GHM and a more closely related paper by Arora (1994) predict that the outsourcing firm=s patents will enable it do so more often than if there were no patents. In light of this, it is not surprising to find some indications of customer-specific investments on the part of outsourcing firms.[61] Rose-Maniace (1996), for instance, describes custom manufacturing firm Albermarle, Inc., which A has patents on S^{+}-ibuprofen production, which it makes in small quantities for a [single] customer in Europe.@ An industry consultant states (Chemical Market Reporter, 1996):

> Instead of dealing with numerous intermediates producers, pharmaceutical companies are relying on a limited number of core suppliers. This sort of close relationship enables fine chemical companies to build up an expertise in the development of particular types of molecules.

The situation is summarized by another industry analyst: “every manufacturing process has a learning curve that [a] new supplier [has] to go through” (Rose-Maniace, 1996). There is thus good reason to believe that in chemical production outsourcing, the production firm=s assets (patents) are what enables it make the customer-specific investments required to manufacture the customer=s product.[62] And it is clear that in the long term, these investments will be firm-specific,

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[61] *See* Gain (1997):

> APreviously, companies would just outsource drug development processes that were fully tried and tested. Now we're seeing chemical manufacturers jointly developing the manufacturing processes with the pharmaceutical companies" to speed their products to market, [a ChemDesign v.p.] says.

[62] Gain (1997) (emphasis added):

> Catalytica's strategy creates a "one stop" supplier for pharmaceutical companies to maximize drug development efficiency and speed. [According to a firm official,] "*[w]e*

and protected, if at all, as trade secrets (Rose-Mariace, 1996).[63]

There is, as one would expect, significant firm entry in this specialized niche as a consequence. According to Chemical Market Reporter (1997):

> [D]emand for fine chemicals continues unabated in the wake of undiminished outsourcing by pharmaceutical makers. Rough estimates put fine chemicals growth at 7 percent annually on a worldwide basis. For producers of fine chemicals this means filled capacities, capital expansions and a string of potential players. “There are lots of newcomers,”noted Nitin Parekh, director of new business with DSM Chemie Linz.

In fact, several established firms have entered this market, by spinning off contract manufacturing operations into independent companies (Chemical Market Reporter, 1997):

> In February of this year, the company [Boehringer] formed a separate business unit promoting its contract process development and manufacturing services for the pharmaceutical and related industries. The unit offers expertise including fermentation capacities for microorganisms as well as for cells of mammalian sources, extraction from

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> *take a [drug] company's manufacturing process and make it cheaper and enable products to be delivered to market faster with the aid of several patented development processes*.@ [This official] cites Pfizer's $15-million investment in Catalytica to develop synthesis steps for drugs such as ziprasidone, an anti-psychotic now in clinical trials, as a vote of confidence.

Of course, the proprietary position of the large pharmaceutical company-customer is also essential to this arrangement. Without a strong patent position, and/or the advantage of FDA approval, this party to the transaction would run the risk of opportunism on the part of the outsourcing firm. It is interesting, therefore, that property rights (patents) are crucial to *both sides* of the transaction.

[63] Rose-Mariace (1996) (quoting industry consultant): AIn the short term, a great deal of process work and patenting is still being done. In the longer term, optimization of the processes will be protected as trade secrets.@

animal and plant tissues, genetic engineering, protein refolding, and protein and enzyme technology.

Importantly, for the story being told here, these newly-formed spinoffs are endowed with a portfolio of patents from the parent firm (Lepree, 1995). SepraChem, a Sepracor spinoff, was created to produce and commercialize intermediate inputs for the drug industry. It operates under licenses to Sepracor=s proprietary technology, which Aincludes 46 US patents for the synthesis of chiral intermediates."[64] This could be interpreted as a re-allocation of assets (e.g., "a2") to a new spinoff firm ("m2") better positioned to make optimizing investments in those assets (as in GHM).

Outsourcing in the chemical production industry thus shows the viability of the thesis advanced in this Article. Patents facilitate arm=s-length trade of a technology-intensive input, leading to entry and specialization.[65] The net result is more investment in specialized chemical production assets. This is part of a larger story in the chemical industry, in which firms adapt to the patent environment and patent protection in turn helps shape industry structure (Arora, 1997). The next section examines how to fit examples such as this into the economic theory of property rights.

4. From Stronger Rights to More Valuable Assets: Beyond the Naive Theory of Property Rights

We have seen that stronger property rights may lead to increased investment in underlying

[64] Lepree (1995). Lepree (1995) also states: ASepraChem presently produces intermediates and actives for Sepracor and other drug companies, using its [proprietary] ChiRedox platform of chiral synthesis and separation.@

[65] *Cf*. Manufacturing Chemist (1997: 11) ("The trend to outsourcing means that small niche companies are springing up to provide contract synthesis and clinical trials . . . .").

assets. This view of things creates a problem, from the point of view of conventional property rights theory. For under the prevailing Anaive@ theory (Eggertson, 1990: 249), legislatures vary property rights only when interest groups push for change. And this, of course, only happens after these interest groups perceive an increase in the value of the underlying assets.

The Anaive@ theory of property rights is usually associated with Harold Demsetz. In a series of early papers, Demsetz (1967) theorized that property rights always adjust to changes in the value of underlying assets. Demsetz= famous example of property rights over fur-bearing animals in Labrador catches the essence of his insight. He sketched a scenario where Native North American Indians hunted beaver and other animals on vast communal hunting grounds, where no specific property rights were defined or enforced. With the coming of Europeans, and the concomitant increase in the value of fur pelts, Demsetz argued that property rights over specific tracts of hunting land began to emerge. Demsetz= simple but powerful conclusion was that property rights were increasingly specified as the underlying asset **C** here, the fur pelts **C** increased in value.

The Demsetz theory has proven to be a robust starting point for a number of very useful discussions. It formed the basis of a more elaborate theory of property rights by Yoram Barzel (1989: 64). It also formed the basic theory tested empirically in a number of papers on the emergence of formal property rights over natural resources (Libecap, 1978; 1989) and land in developing countries (Besley, 1995; Alston, Libecap and Schneider, 1996). Finally, it has been refined and extended in a number of significant recent attempts to craft a more nuanced theory of property rights (Ellickson, 1993; see generally Eggertson, 1990).

The analysis in section 2 of this paper suggests the need for some modifications to the naïve theory, at least as applied in IPR contexts. In the examples we studied earlier, and perhaps in the real-world case of chemical intermediate firms, a re-specification of rights led to higher investment in the *creation* of economically useful assets. The property right, in other words, came first. True, the state, in its capacity as rights-granting entity, must have recognized the potential

for this investment. (This is hinted at by North (1990).) But the fact remains that in these examples, the property right stimulated investment. This is contrary to the simple story of Demsetz, where asset values increase and property rights adjust – almost magically, it seems – in response.

To be fair, others also criticizes the simplicity of the naïve theory (Eggertson (1990); North (1990) (introducing crucial political economy issues). The point here is simply that the evidence in the IPR setting lends credence to these critiques. It also points up the need for a more dynamic, interactive account of the relationship between property rights specifications and asset values.

5. Conclusion

Clearer IPRs lead, under some conditions at least, to increasing specialization. For there to be gains from trade in the input markets described here (especially net of transaction costs), the underlying assets covered by the IPRs must be made more valuable by the specialized investments of the input supplier. Since these investments are made possible by the property rights over the assets, clearer property rights can be said to increase the value of the underlying assets.

The theory of this paper accounts for recent empirical evidence linking stronger IPRs to a greater incidence of licensing activity. It also contributes to our understanding of why the explosion of interest in transaction-intensive organizational forms (joint ventures, outsourcing, R&D consultants, etc.) has taken place during an era of clearer IPRs.

One cautionary note is in order. This paper does not suggest that defining clear property rights, and providing an enforcement mechanism, will always increase the value of the underlying assets. As several authors have discovered (Reynolds and Merges, 1997; Heller and Eisenberg, 1997), efforts to define ownership rights will not always increase efficiency. Indeed, at times

property rights create new transaction costs that decrease efficiency compared to the preceding equilibrium. This is the general point of Heller's (1998) theory of the "anti-commons." To make new property rights worthwhile, there must be potential gains from trade that justify investments in market-making activities. The simple argument advanced here is that sometimes these conditions hold. Whether there are greater efficiencies than isolated interest groups realize, or whether only policymakers grasp the potential gains, the point is that the older, "naïve" model of property rights **C** in which asset values "pull" new property rights into being **C** is inadequate. In certain cases at least it is new property rights that "push" asset values upwards.

As a final note, the GHM literature, with its emphasis on *ex ante* production incentives, echoes themes that resonate in traditional views of a well-functioning patent system. Indeed, it might even be said that refocusing attention on the role of patents in the production process might be one of the more interesting lessons to be learned from a careful reading of GHM and related sources. At a minimum, the idea that property rights ought to be about encouraging productive investments may have some modest payoff. Just to take one example, the concept of residual rights is shown to exert powerful effects on economic behavior, at least in some cases. It follows that there may be significant social costs, again at least in some cases, when these rights are improperly awarded. In the case of patents, this may occur if validity standards are not rigorously applied – e.g., if technology that is in fact old is protected by a patent because the system spent too few resources searching the "prior art." If legislatures and courts enhance the economic power of property rights, it is at least worth exploring whether it makes sense to increase the resources devoted to the process granting those rights. Otherwise we are ignoring an important implication of the literature on the power of property rights.

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