

A THEORETICAL AND EMPIRICAL INVESTIGATION OF PROPERTY RIGHTS SHARING IN
OUTSOURCED RESEARCH DEVELOPMENT AND ENGINEERING RELATIONSHIPS

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May 2012

Forthcoming, Strategic Management Journal

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ABSTRACT

Research, development, and engineering activities are increasingly outsourced to external contract research organizations. This paper develops and tests an incomplete contracting theory in which property rights are used to structure bargaining positions to safeguard transaction specific investments in the context of client-sponsored RD&E. By focusing on the positive externality created by uses of the technology other than those targeted by the client, the theory produces a novel set of predictions which diverge from standard transaction cost and property rights reasoning; viz., greater contractor property rights are associated with more transaction specific investments by the client. Contractor property rights are also predicted to increase as environmental uncertainty increases and as more applications of the technology fall outside the client's intended fields-of-use. Contract-level data from 147 RD&E agreements in technology-intensive settings provide support for these predictions. The theoretical mechanism is further supported by a secondary examination showing that clients who share property rights with their contractors face reduced opportunism during project execution. The safeguard is attractive from a practical standpoint because it uses limited control which is well suited to the creative tasks typical of RD&E.

INTRODUCTION

Recent National Science Foundation data show an increasing use of outsourced RD&E, particularly in high technology industries (NSF, 2011). Proponents of outsourcing cite a number of benefits, including its ability to reduce costs, improve flexibility, shorten time-to-market, and gain access to the specialized resources of external suppliers. Regardless of the motivation, the growth in outsourced RD&E has made the governance of these relationships increasingly important.

The traditional internalization of RD&E suggests the existence of exchange hazards for which clients desire safeguards (Williamson, 1985). Indeed, the orthodox transaction cost arguments that have been used to analyze the governance of RD&E (e.g., Pisano, 1990; Teece, 1988; Ulset, 1996) suggest that firms turn away from external relationships toward hierarchies for two principal reasons; hierarchies provide stronger safeguards against the expropriation of non-contractible transaction specific investments and they adapt better to fast changing circumstances by limiting conflict during ex post adjustments. Since most tasks in RD&E involve specific investments and are subject to uncertainty and incomplete contracts (Pisano, 1990), outsourcing should be particularly rare. Yet, the empirical evidence beginning with the “Yale” studies (e.g., Levin et al., 1987) suggests the opposite. Not only are RD&E activities frequently outsourced, but descriptions of outsourced RD&E often present clients continuing to engage contractors despite difficult renegotiations. For example, Lerner, Shane, and Tsai (2003) estimate probabilities of renegotiating RD&E agreements before planned completion at between 37% and 58% depending on exogenous conditions.¹ Apparently, these renegotiations are seen as a cost of generating efficiencies elsewhere rather than grounds for internalization.

Perhaps more strikingly, the tight hoarding of intellectual property rights (IPRs) so strongly advocated in the practitioner literature is often at odds with the wide range of allocations observed in practice. IPRs over newly developed technologies are often shared with contractors even though they do not make unusually large unreimbursed investments. To illustrate, Robinson and Stuart (2003) report that of 3,168 genomics related RD&E relationships in the Deloitte ReCap/Recombinant Capital database, 56% involved licensing arrangements in which the RD&E performing firm retained property rights to royalties

from the technology. While the predominant theme in the strategy literature emphasizes the dangers of technology sharing and leakage, there may be net advantages from less restrictive IPR provisions when opportunism is a pronounced exchange hazard during development.

In this paper, we examine incomplete contracting motivations for sharing IPRs with contractors in outsourced RD&E. The hypotheses are developed in the context of client-sponsored RD&E, a common arrangement in industry (Majewski and Williamson, 2002). As discussed in detail by Pisano (1990) and Ulset (1996), the primary exchange hazard in these relationships arises from the contractor-specificity of the work-in-process, which is often tacit and uncodified prior to final delivery. This imperfect transferability makes the asset developed as a result of the client's financial investment specific to the contractor and thus subject to ex post bargaining.² The practical concern is that opportunistic contractors will take advantage of this to delay delivery, shirk in developing the technology, or inflate the cost. While client opportunism is also possible if reimbursement is withheld or the client attempts to bargain within the framework of a cost-plus arrangement, there are self-enforcing limits to this since the client is hurt by any associated delays and the contractor can withhold delivery of the technology in response.

In the theory below, IPRs are shared by the client in order to alter the bargaining positions of the two parties. By sharing property rights, the client increases contractor dependence on relationship continuity and puts the contractor in a weaker bargaining position ex post. The benefit to the client is reduced contractor opportunism during development. The cost is the loss of exclusivity over the technology, which is controlled through field-of-use restrictions. The central logic is one of arbitrage, where the client shares less valuable IPRs in adjacent fields-of-use in order to realize gains from more efficient development in its critical intended fields-of-use.

The use of IPRs to influence ex post bargaining can be viewed as a form of dependence balancing, as introduced by Heide and John (1988) and Heide (1994). Unlike dependence balancing via separate offsetting investments made by each party, the present study considers the sharing of IPRs resulting from the principal investment made by the client. While the core dependence balancing logic captures the spirit of the analysis, greater concreteness and generalizability is added by appeal to the

economic literature on property rights which formalizes the notion of dependence in the form of quantifiable quasi-rents and allows a more detailed analysis of the conditions under which more balanced dependence will enhance efficiency (Grossman and Hart, 1986; Hart and Moore, 1990; Hart, 1995).

Importantly, we expand on all existing incomplete contracting approaches by considering the positive economic externality created by uses of the technology beyond those targeted by the client. IPRs within and outside the client's intended uses are unbundled and assigned in a more discriminating way than in extant theories; viz., to protect the client's key areas of concern while aligning interests among development partners. This distinction is important, since this externality drives the novel predictions relative to both transaction cost economics (TCE) and property rights theory (PRT). It also assures us that more balanced dependence will enhance efficiency. Absent the arbitrage opportunity, or within the client's intended fields-of-use, we expect standard TCE/PRT predictions to hold and for less balanced dependence to be more efficient. While we rely principally on the dependence balancing and PRT literatures to frame our discussion, other aspects share commonalities with TCE and agency theory. In what follows, we adhere to Williamson's dictum:

No comprehensive commitment to one approach needs to be made. What is involved, rather, is the selection of the approach best suited to deal with the problem at hand. Although the method of matching models to problems is not always easy, I find the alternative of forcing one model to handle all the issues to be even less satisfactory (1975, p. 249).

The study has clear implications for the governance of outsourced RD&E. In addition, it contributes to the broader literature on interorganizational governance in strategic management by focusing on the allocation of IPRs in the context of creative activities. Interorganizational ties are replete with relationships involving creativity in which control-based safeguards or activity-focused contracts may cause serious inefficiencies (e.g., Damanpour, 1991) to which IPR-based safeguards are not subject. The theory also provides a rationale for rights sharing that does not rest on power or monopoly resource considerations; viz., that power allows the contractor to demand IPRs (among other compensation) as a condition for its participation in the relationship. Finally, IPRs are important because they provide a contractible basis for performance incentives in otherwise incomplete development agreements.

BACKGROUND

National Science Foundation data show a marked increase in contract RD&E over the last several decades, as illustrated in Figure 1 (NSF, 2011). Non-federally funded industrial contract RD&E increased from about \$1.8B in 1977 to \$19 billion in 2007 (constant 2005 dollars). The proportion of total RD&E performed on a contract basis increased from 3% to 7% over the same time period. The percentage of firms contracting-out RD&E stood at 18% across all industries in 2007, up from less than 10% ten years earlier. However, this rate is considerably higher in the technology intensive industries included in our study, where the latest NSF data show percentages as high as 58% in drugs and medicines. Indeed, the NSF data understate the phenomenon since they do not include RD&E contracted outside the U.S.

--- Figure 1 About Here ---

RD&E relationships occur in both collaborative and contract forms (Majewski and Williamson, 2002). Our focus is on contract RD&E relationships between clients and independent contract research organizations (CROs) where the work is financially sponsored by the client. The development agreements in these relationships are typically incomplete in many technical and business respects. This arises from the difficulty of specifying the details of novel RD&E work ex ante as detailed by Aghion and Tirole (1994), Pisano (1990), and Lerner and Malmendier (2005). One industry insider puts it this way:

Redefining the work when the unexpected happens, as it invariably will, [is essential]. Research is by its very nature an iterative process, requiring constant reassessment depending on its findings. If there is a low risk of unexpected findings requiring program reassessment, then it is probably not much of a research program (Sherbloom, 1991, pp. 220-221).

Bajari and Tadelis (2001), Bannerjee and Duflo (2002), Crocker and Reynolds (1993), and Lerner, Shane, and Tsai (2003) all provide comprehensive accounts of the incompleteness of contractual agreements covering RD&E tasks. Hence, our analysis assumes incomplete contracts that create a substantial latitude for opportunism.

As discussed in detail by Williamson (1985), opportunism is the guileful violation of expected or promised behavior, undertaken in order to redirect profits from vulnerable partners. Vulnerability arises due to transaction specific (i.e., specialized, complementary) assets that lock firms into bi-lateral

exchange by generating higher returns in the relationship than in their next best (reservation) use. This difference is called a quasi-rent, and it is exploitable by opportunistic partners who employ various hold-up threats to bargain over these returns (Klein, Crawford, and Alchian, 1978). In the present investigation, the returns center around the intellectual property rights created in successful development relationships.

In the modern literature, property rights are defined by residual rights of control (Grossman and Hart, 1986). Residual rights refer to those not constrained by contract or otherwise restricted by law (Milgrom and Roberts, 1992). Property rights grant control over the use of an asset as well as its returns (Furubotn and Pejovich, 1974; Milgrom and Roberts, 1992). They also allow parties to exclude others from exercising control or claiming returns (Holmes, 1881/1946). Because property rights are based on residual control, they can arise from formal ownership of intellectual property or from contractual arrangements that assign usage or other residual rights (Grossman and Hart, 1986; Milgrom and Roberts, 1992). These include licensing, royalty, revenue-sharing, and non-disclosure/non-compete agreements.

Importantly, even though the actions of RD&E contractors are generally not contractible *ex ante*, incomplete contracting theorists view property rights themselves as contractible since they do not require an *ex ante* account of specific *ex post* activities (Aghion and Tirole, 1994; Grossman and Hart, 1986). That is, they are *residual* rights of control. Indeed, most legal regimes assign a default distribution of these rights which presupposes an ability to write them into contracts. For instance, under American law, the client is the default owner of intellectual property derived from the RD&E projects it sponsors. Other legal regimes favor the contractor as the default property owner because its efforts “produce” the IPRs.

One aspect of IPR allocations that will play an important role in the analysis below is field-of-use restrictions. In practice, the client will always hold rights to use the technology within its intended fields-of-use, although these may be jointly held or established by license rather than ownership. However, IPRs outside the client’s intended fields-of-use are shared more liberally. This leads to an additional aspect of the technology that we consider, targetability. In the technology development literature, Hauser and Zettlemeyer (1996) denote Tier 1 projects as those that are close to basic science. Such projects are less “targetable” in the sense that the developed solutions are likely to be useful in applications beyond the

client's intended fields-of-use. Tier 2 projects involve technologies that pertain largely to the specified applications at hand, but may also have applications in adjacent fields-of-use. At the other end, Tier 3 projects focus on incremental improvements that apply only to the intended uses of the client.

Extracting the full value of developed technologies becomes increasingly difficult as projects move from Tier 3 to Tier 1 because many of the applications in the latter projects lie beyond the client's current served markets, and de novo entry is always problematic. Licensing to incumbents in outside markets is an alternative possibility, but licensing is also a highly imperfect process that yields relatively small returns to the owner (Levin et al., 1987). Notice that Tier 3 projects present few opportunities to efficiently share IPRs since there are few applications where low value rights (from the client's point of view) can be shared. In contrast, Tier 2 and especially Tier 1 projects offer fields-of-use where rights may be shared at a lower opportunity cost to the client. These rights are often valuable to the contractor since the intellectual property can be used in performing work for clients in other fields. In certain cases, the contractor will make a subsequent investment to further develop its property rights, but more commonly this work is performed as part of its contract work for another client.

Field-of-Use Distinctions in Technology Contracting

While distinctions between different fields-of-use are common in technology contracting (e.g., Teece, 2000), this issue has received relatively little theoretical attention, particularly in the economic literature on property rights. This stems in large part from data limitations, since contractual terms are private and rarely disclosed. A notable exception occurs in large-scale cooperative RD&E, where contractual terms are often released because they are of material interest to shareholders or subject to government reporting requirements under the National Cooperative Research Act of 1986 and/or the National Cooperative Research and Production Act of 1993. These relationships typically extend beyond pure contract RD&E, however they are nevertheless instructive.

To illustrate the importance of field-of-use distinctions in property rights contracting, consider a series of relationships involving Millennium Pharmaceutical from the Deloitte ReCap/Recombinant Capital database of cooperative biotechnology alliances (www.recap.com). In the Millennium-Aventis

alliance of 2000, IPRs were split by field-of-use, with Aventis having first-option to gene therapy and vaccine products and Millennium first-option for antibody and diagnostic products. In the 1998 Millennium-Bayer alliance, Bayer held the right to select a subset of qualified targets for its exclusive use, whereas the RD&E performing firm Millennium shared rights to all remaining QTs. In the 1997 Millennium-Monsanto alliance, the companies shared rights in human-health related fields, while Monsanto held exclusive rights in agricultural and livestock related fields. In the 1996 Millennium-American Home Products alliance, Millennium acquired rights to use AHP's small molecule library in its own work on central nervous system disorders, outside the field of collaboration. While these examples are primarily alliances, field-of-use distinctions are also common in pure contract RD&E; for example, deCode Genetics received rights to all shelved projects in its 2001 work for Roche as well as rights to the principal research for use in bioinformatics, an area outside Roche's field-of-use. Similarly, in the 1982 GI-Sandoz alliance, the RD&E performing firm GI received a non-exclusive license to the technology "outside Sandoz areas of interest."

The importance of field-of-use distinctions became evident during our field interviews with twelve R&D managers and patent attorneys that we conducted prior to our survey to understand the ground realities in contract RD&E. In each case where a company shared IPRs with its RD&E contractor, the technology involved had applications that could not be exploited by the firm. One example was a battery technology for an implanted medical device. When shared, IPRs were always restricted by field-of-use to protect the client's interests. Other common contractual restrictions addressed duration, territory, and reach-through to future innovations.

To gain a better feel for the relationships in our data, we compared the ten observations with the highest levels of contractor IPRs with the ten observations with the lowest levels of contractor IPRs (broader comparisons are left for the empirical work below). The top ten group all involve technologies with wide-ranging applicability. One is a technology to reduce wear in artificial hip joints. This technology is useful in other orthopedic applications, however these fall outside the client's intended uses since it only manufactures hip joint components. A second is an ultrasonic technology that the client will

apply in the field of renal treatment, but which the contractor has the right to use in other fields, per the informant's written description of the project. This group also contains a software/firmware solution for use in process measurement instrumentation that the informant described as useful to the contractor in its work in other fields. In contrast, the bottom ten relationships are very much of a Tier 3 nature involving work that is relevant largely or exclusively within the client's domain. These include a new dimple design for a major golf ball manufacturer and several relationships to design new circuitry or software for specific products, including an anesthesia delivery device and a printer. In general, the top IPR sharing relationships involve a higher proportion of research compared to development (suggesting Tier 1 to Tier 2 type projects), greater client investment, and more discontinuous innovations.

The Property Rights Approach to Incomplete Contracting

Like TCE, the property rights approach views incomplete contracts and ex post quasi-rents as critical determinants of governance design. Firms arise to allocate residual rights of control efficiently in situations where markets fail due to complementary assets. As reviewed by Hart (1995), control in the form of integration is recommended to the extent that assets are complementary (specific) rather than independent (Propositions 2c and 2d), and one party's (elastic) investment is more important (productive) than the other's (Propositions 2a and 2b).

Operationally, PRT focuses on the ex post bargaining that occurs within incomplete contracts. Altering the assignment of property rights shifts the quasi-rents (dependence) of each party by changing their non-cooperative payoffs. This in turn alters the division of the cooperative surplus (quasi-rents) in the bargaining outcome even though the relationship does not terminate. Importantly, shifting the division of the surplus changes the bargaining externalities affecting each party's ex ante investment in complementary assets. Giving IPRs to the party making the more important specific investment reduces its bargaining loss (spillover) and thereby increases its incentives to invest. This enhances efficiency by leading to greater investment in the more important asset. Indeed, in certain situations, parties making more important specific investments should be given a greater share of IPRs even to the point of causing

over-investment (Grossman and Hart, 1986). Since the client makes the key exposed specific investment in client-sponsored RD&E, traditional PRT would prescribe strong client control of IPRs in this context.

While the core PRT predictions are similar to the more familiar TCE, the theory differs in several subtle but important ways. Most notably, while TCE predicts governance mode, it does not predict the direction of integration (i.e., who acquires whom).³ In contrast, this issue is central to PRT, which is concerned to a far greater degree with the allocation of power between the parties under integration and quasi-integration. In particular, knowing which party accumulates IPRs at the expense of the other is imperative in our analysis since the firms remain independent and differ in the importance of their unreimbursed specific investments. More balanced dependence in our context involves a shift of power from the client to the contractor, which has specific implications for efficiency given the largely one-sided pattern of specific investments.

Second, PRT assumes that parties bargain regardless of governance structure (Grossman and Hart, 1986). This contrasts with TCE, where fiat, low-powered incentives, non-monetary compensation, and other aspects of the firm are assumed to constrain bargaining under integration (Williamson, 1985).⁴ From a TCE point of view, inefficiencies change across governance structures; for example, bargaining in interfirm relationships is replaced by bureaucratic distortions and weaker performance incentives under common ownership. Rather than relying on such assumptions, PRT provides a micro-analytic explanation of how governance alternatives differ with respect to the costs associated with ex post bargaining. In particular, our analysis does not assume that parties are more charitably disposed toward one another just because dependencies are more balanced.

Third, PRT focuses very specifically on distortions in ex ante investments as the principal inefficiency associated with ex post bargaining (Whinston, 2003). In contrast, TCE recognizes many other costs of bargaining (e.g., maladaptation, time and effort) and governance (e.g., set-up costs, bureaucratic distortions) which occur both ex ante and ex post. This limitation of property rights theory reflects its development in formal economic models, in which transfers of wealth do not impact efficiency if bargaining is frictionless, but for ex ante investment distortions. We expand on this view below in that we

recognize certain costs of bargaining and thus expect the behaviors associated with it to vary as a function of the expected payoff.

The modern property rights approach also differs from an earlier classical literature that views property rights and complex governance forms such as integration as arising in order to maximize efficiency by: (1) internalizing externalities (Demsetz, 1967); (2) reducing negotiation and enforcement costs (Demsetz, 1967; Cheung, 1968); (3) economizing on system-wide measurement costs (Barzel, 1982); (4) sheltering risk-averse employees from uncertainty (Cheung, 1969; Knight, 1966); and (5) creating incentives (through residual profit claimancy) to monitor cooperative inputs when outputs cannot be measured efficiently (Alchian and Demsetz, 1972). In contrast to the modern literature, this stream is far more concerned with measurement and negotiation costs. Ironically, these issues are largely overlooked by the contemporary literature, although recent developments are returning to such issues (e.g., Spier, 1992; Klein, 1996; Tirole, 2009). In addition, whereas the older literature views ownership primarily in terms of claims on residual profit, the modern literature is principally concerned with the more immediate notion of residual control (Milgrom and Roberts, 1992; Chi, 1994). While we draw on the modern version of the theory, aspects of the analysis such as the incentive effects of IPRs on cooperation are consistent with the classical literature and other approaches such as agency theory.

HYPOTHESES

We assume that the firms enter into a development agreement *ex ante* specifying IPRs over the completed technology. The client then decides how much to invest in the relationship. Since the contractor may also invest unreimbursed resources of its own, we allow for this possibility. The contractor's investment could be financial, but since most of its expenses are reimbursed by the client, we have in mind other non-contractible investments such as effort above the level necessary for reimbursement under the development agreement.⁵ The client will manage the relationship to both claim value by safeguarding its investment and create value by protecting the contractor's incentives to invest.

The *ex post* period begins after investments are sunk. The parties can now bargain over quasi-rents in the relationship, with the new division of the surplus reflecting their *ex post* bargaining positions.

Following PRT, we conceptualize opportunism as a Nash (1951) bargaining game. Formally, Nash bargaining specifies that each party receives its reservation or breakdown payoff plus an equal share of the total bargainable surplus (quasi-rents) from completion. The key insight from Nash bargaining is that each party's bargaining position is an inverse function of its own quasi-rents.

Since the client makes the predominant unreimbursed specific investment, the contractor's quasi-rents are typically quite small when bargaining occurs. Hence, the contractor's dependence is low and its bargaining position is relatively strong. However, possession of IPRs changes this because the contractor's IPRs are more valuable under the default legal provisions reviewed above if the project does not breakdown. As the contractor's share of IPRs grows, it stands to lose ever-larger amounts with breakdown. This increases its dependence and reduces its bargaining position vis-à-vis the client. In essence, IPRs act as hostages that increase the contractor's dependence leading to self-enforcing limits on opportunism (Williamson, 1983). While the contractor can always bargain, its bargaining power and the amount it is able to capture decline as a function of its IPRs. This, in turn, should lower its incentives to engage in opportunistic behavior, which carries costs in practice due to the effort involved, damage to the contractor's reputation, and delays (if vested with IPRs). Hence, as its dependence increases and gains from bargaining decrease, we expect the contractor to initiate such actions more sparingly.

The first variable we consider is the specificity of the client's investment. As the client's investment becomes more specific, its quasi-rents increase, weakening its bargaining position. The client will anticipate this vulnerability, and invest less ex ante if safeguards are not erected. Increasing the contractor's IPRs raises contractor dependence and reduces contractor opportunism as described immediately above, thereby providing a safeguard for the client which enhances efficiency due to the importance of the client's investment.⁶ As a further benefit, sharing IPRs with the contractor also increases its incentives to invest effort. This provides an additional benefit in the form of improved technology.⁷ Thus, as the specificity of the client's investment increases, we expect the client to share more IPRs with the contractor.

Hypothesis 1: More specific investments by the client are positively associated with contractor IPRs, ceteris paribus.

Turning to uncertainty, both property rights and dependence balancing models are typically silent with respect to this variable, except as it is implied by incomplete contracting. Hence, we start with Williamson's (1985) fundamental argument linking greater environmental uncertainty to increased opportunism. In the present context, the development agreement acts as a safeguard, but this is contingent on the desire of the parties to refrain from renegotiations. As uncertainty increases, ex post adjustments become more likely, in which case the contractor can bargain opportunistically. Hence, greater uncertainty tends to be associated with more contractor opportunism. This heightened vulnerability is again anticipated, making the client less willing to invest ex ante unless safeguards are erected. Since contractor IPRs act as safeguards by balancing dependence and weakening the contractor's bargaining position, we expect that the client will share IPRs to a greater extent as environmental uncertainty increases.

Hypothesis 2: Uncertainty is positively associated with contractor IPRs, ceteris paribus.

Turning to targetability, the IPR safeguard is based on an arbitrage opportunity that allows the client to share less valuable IPRs in adjacent fields-of-use in order to safeguard its returns in more critical intended fields-of-use. In particular, the client should look to purchase its safeguard using those IPRs that cost it the least to share, preferably those that are entirely outside its targeted applications. Sharing such rights has a small effect on the client's gains from the relationship, yet can enhance the contractor's quasi-rents substantially since it can use these rights in its subsequent contract work for clients in other fields.⁸ Thus we expect relationships with larger externalities from non-targeted applications (i.e., Tier 1 versus Tier 3 projects) to have stronger arbitrage opportunities and thus greater IPR sharing.

Hypothesis 3: The extent of applications outside the client's intended uses is positively associated with contractor IPRs, ceteris paribus.

As alluded to above, the core prediction on specificity differs from extant theoretical models. Both TCE and PRT suggest that a party should be given more control (in this case of IPRs) as the specificity or complementarity of its investment increases (Hart 1995; Williamson 1985). We predict the

opposite by focusing on the dependence balancing role of IPRs (relative to TCE) and non-targeted applications of the technology (relative to both TCE and PRT). It is also interesting to contrast the hypothesis with what we would expect from a simple performance incentive perspective. As specificity increases, the client loses more and more of its benefit from the contractor's effort during ex post bargaining. Hence, we would expect it to scale back costly performance incentives (IPRs) as specificity increases, in contrast to the hypothesis. The uncertainty prediction also differs from TCE and performance incentive perspectives (the other theories are silent on uncertainty). TCE would suggest that a party facing greater uncertainty (in the presence of non-zero specificity) would exercise more, not less, control over IPRs. Similarly, a simple performance incentive perspective would see the client gaining less from contractor effort as uncertainty (and opportunism) increase, resulting in reduced sharing of IPRs.

Finally, property rights act as hostages in a manner similar to Williamson's (1983) classic treatment. However, the hostage is provided by the party vulnerable to opportunism and given to the party prone to opportunism. This differs from the "ugly princess" of Williamson's model which is a bond posted by a party to assure its own forbearance. We might refer to IPRs in the present theory as more of a "beautiful ambassador" that can be recalled by the client should the contractor act opportunistically. Importantly, this reverses the empirical predictions of the two approaches; as the client's investment becomes more specific, Williamson's model would predict greater issuance of hostages by the contractor, not the client. In the present context, this would involve a shift of IPRs from the contractor to the client, whereas we predict the opposite.

To gain additional insight, we also offer a secondary examination of the direct effects of IPRs on contractor opportunism. Williamson's (1996) principle of remediable efficiency, according to which governance remedies are limited to a feasible set of imperfect options, and the fact that safeguarding carries a cost which increases at the margin, both suggest that equilibrium levels of safeguards will be reached before the effects of opportunism are entirely eliminated. This is true particularly in quasi-integrated forms, where governance remedies are of an intermediate variety and integration under

common ownership is not at issue. As discussed above, property rights models also predict opportunistic bargaining in equilibrium.

However, a complexity arises in that governance is self-selected by the parties, hence we proceed with a degree of caution. In our context, the parties first select a level of contractor IPRs in an effort to reduce opportunism. Then, this choice of governance effects the levels of opportunism that are actually observed. Ideally, we would address this by assigning relationships to governance structures at random and observing the effects on opportunism. While this is clearly infeasible, econometric techniques exist to produce consistent estimates of the desired effects under such conditions (Masten, 1993; Hamilton and Nickerson, 2003). These procedures have been used in similar research, such as the investigation of Masten, Meehan, and Snyder (1991) into the costs of organization.

We begin with the central prediction on contractor opportunism. The core mechanism of the theory leads us to expect a negative relationship between IPRs granted to the contractor and contractor opportunism.

Hypothesis 4: Contractor IPRs are negatively associated with contractor opportunism, ceteris paribus.

In addition, as the client's investment becomes more specific, its quasi-rents increase, thereby amplifying the contractor's gains from and incentives for, opportunism.

Hypothesis 5: A positive relationship exists between the specificity of the client's investment and contractor opportunism, ceteris paribus.

The effect of uncertainty is much the same. Uncertainty increases the incidence of ex post renegotiations as discussed above, which should also increase contractor opportunism.

Hypothesis 6: A positive relationship exists between uncertainty and contractor opportunism, ceteris paribus.

The last two hypotheses are important because we also examine the interaction of these variables with contractor IPRs. The negative effect of contractor IPRs on contractor opportunism should become more pronounced as client investments become more specific and as environmental uncertainty increases since the opportunity for a safeguard to evidence its effect should increase as the factors facilitating

opportunism increase. This affords us an additional test of the safeguarding property of contractor IPRs beyond that in Hypothesis 4 which is in some sense stronger since it involves moderating effects on the facilitator-opportunism relationship.

Hypothesis 7: Contractor IPRs and the specificity of the client's investment have a negative interaction effect on contractor opportunism, ceteris paribus.

Hypothesis 8: Contractor IPRs and uncertainty have a negative interaction effect on contractor opportunism, ceteris paribus.

EMPIRICAL STUDY

The propositions are tested using data collected from clients who engaged contractors on RD&E projects using a key informant methodology. Our field interviews led to three design decisions. First, clients are responsible for financing, managing, and evaluating the performance of sponsored development relationships. Hence, client managers serve as our key informants. Second, knowledge about development relationships is quite concentrated within the firm. Thus we searched for the most qualified informant from the client organization. As a result, the modal informant holds the rank of vice-president. Third, clients were reluctant to share the identities of their contractors since these relationships are a source of competitive advantage. Hence, we collected data from only a single side of the dyad.

We drew a sample of firms to participate in the study in the following manner. In order to ensure a sufficient number of outsourced development projects, we used data from the NSF Survey of Research and Development in Industry to identify the top five two-digit SIC codes in terms of R&D intensity (R&D/sales). Next, the top five three-digit industries from these five groups were selected in terms of the percentage of firms outsourcing R&D. The final sampling frame consists of drugs and medicines (283), optical, surgical, and photographic instruments (384-387), communications equipment (366), motor vehicles and equipment (371), and aircraft and missiles (372, 376).

Ideally, we would sample outsourced RD&E projects at random within these industries; however no list of such projects exists. Hence, we turned to a national list broker to compile a list of engineering, product, and R&D managers within the selected industries. Managers were selected at random from the broker's list, with a single manager per firm. We attempted to contact each of the 2,600 individuals to

solicit the participation of their firm. Typically, several referrals (three to four on average) were necessary in our phone conversations to reach a qualified informant (different from the original contact) who had managed a sponsored development project. Once found, we asked the informant to identify a project where their firm had engaged an independent CRO. In the event that an informant had been involved in several projects, we asked them to choose the one they were most familiar with regardless of its success to ameliorate problems of social-desirability (Montoya-Weiss and Calantone, 1998).

Once identified, we mailed informants a questionnaire, which required about an hour to complete based on our pre-tests. As an incentive, we offered to provide them with a “par” report comparing their company’s practices and experience with other firms after controlling for relevant differences. We also offered them access to a private website where they could participate in a discussion board format.

Of the 2,600 initial names, 635 were invalid because their firm was no longer in business, or the individual was no longer employed at the company. In the latter instance, we asked to be referred to another individual. The 635 includes only those cases where we could not get a referral. In another 670 cases the original contact or the referral could not be reached after an effort of five phone calls and two messages. In this case our efforts with the firm ceased. Of the managers contacted, 226 reported that no RD&E work was conducted in their unit, while 496 said that they did not engage contractors for such tasks. Again, these numbers include only those cases where we could not get a referral to a unit that outsourced RD&E. Another 168 individuals reported their firms engaging contractors, but declined to participate, in which case our efforts terminated. This left 405 qualified informants who verbally agreed to participate in the survey. Upon mailing the questionnaires and following up with reminders and a second mailing, we received 147 completed surveys (36% of 405 mailed). This response rate is on par with surveys on similar inter-organizational issues. We assessed non-response bias by comparing early and late respondents across all the measured variables. No significant differences were found across the two groups. As a second check, we found that non-response rates did not vary by SIC code.

Measures

We measure the variables using multi-item psychometric scales. Psychometric measures are well suited to the measurement of complex constructs such as opportunism and specificity, but suffer from the inability to retrieve accounting and other archival data. The Measurement Appendix contains the items, anchors, and response formats for all constructs.

Contractor IPRs measure the extent to which the contractor shares in property rights over the technology. Given the absence of any prior scale in the literature, we appealed to the legal and economic literatures to develop the individual items (e.g., Clarkson et al. 1989; Milgrom and Roberts 1992). Property rights are typically divided into ownership rights, usage rights, and rights to financial returns. Hence, these serve as the foundation for our scale. In addition, both the legal and economic literatures emphasize the ability to exclude others as part of the definition of property rights (Holmes 1881/1946). Therefore, items in the scale focus on both the contractor's rights as well as the extent to which the client was prohibited from certain actions. Since rights may be of different values and may be shared fully or partially, we ask about many of the rights granted to the contractor in terms of their overall significance. Given our reliance on the categorization of the domain from the literature, we model these items as a formative scale (Jarvis, MacKenzie, and Podsakoff 2003). All items are preserved in the final measure and the item scores are averaged to get the score for the overall scale.

Contractor opportunism measures strategic self-interest seeking behavior undertaken in order to redirect profits from vulnerable partners. Our eight-item scale is adapted from John (1984). The items tap a number of opportunistic behaviors that the contractor may exhibit during project execution.

Client specificity measures the extent to which the client's investments are characterized by limited redeployability and limited salvageability. We measure the specificity of the client's investment with a five-item scale adapted from Anderson (1985).

Market and technical uncertainty measure the degree of unforeseen change in these two domains. Market uncertainty is measured with five items adapted from Moorman and Miner (1997) that describe unforeseen changes in the market for the client's product. Technical uncertainty is measured with four

items specifically developed for this study that assess changes in the underlying technologies used to perform the contracted tasks.

Outside applications measures the extent to which the technology has applications beyond those uses targeted by the client with five items developed specifically for this study.

Control Variables

We complete the modeling of contractor IPRs with several control variables found in the governance literature.

A competing explanation of contractor IPRs is that they are concessions extracted from clients by powerful contractors. *Available suppliers* uses a single item to measure the number of equally or better qualified companies from which the client could have chosen the contractor at the outset of the development agreement (i.e., the inverse of monopoly power). We expect a negative relationship between the number of available contractors and contractor IPRs. This variable may control for other factors as well; monopolist contractors may use their power to alter prices in the relationship or may be better able to expropriate gains through hold-up. In the latter case, we would similarly expect a greater use of the IPR-based safeguard.

Second, *client skills* measures the ability of the client to perform the contracted task with eight items describing competencies embedded at the unit level as well as competencies embedded in individuals within the unit. Clients without the relevant resources required to internalize tasks are also less capable of exercising control over a contractor. These clients should offer contractors more discretion and rely on property rights as a safeguard more than control. Thus, we expect a negative relationship between client skills and contractor IPRs.

Third, *task creativity* measures the creativity required to undertake the contracted task with five items adapted from Amabile et al. (1996). The literature on creative tasks has stressed the importance of motivation and discretion (e.g., Damanpour 1991). Property rights should motivate the contractor, and control-based safeguards, which limit discretion, should be less attractive for creative tasks. Hence, we expect greater contractor IPRs when tasks require higher levels of creativity.

Finally, we include a measure of *contractor investment* as a control variable in the models for both contractor IPRs and contractor opportunism. We expect contractor investment to be positively associated with contractor IPRs since greater contractor investment results in superior technology and greater benefit to the client, which justifies increased safeguarding. Contractor investment might also result in lower opportunism since it increases contractor quasi-rents; though it is not clear that its effect on client quasi-rents (through superior technology) would not be greater, suggesting the opposite effect. This construct is measured with a five-item scale adapted from Anderson (1985).

ANALYSIS AND RESULTS

Measure Validation

The multi-item measures are subjected to an analysis of their reliability and validity following standard psychometric techniques using Mplus 3. Questions with low item-total correlations, low item reliabilities (i.e., a low percentage of trait variance), or which significantly reduced construct reliability or validity were removed. Following deletion of ill-fitting items, we estimated a combined congeneric measurement model for the multi-item reflective scales as illustrated in Figure 2. Fit statistics for the model are also given in the Figure and indicate a good fit to the data. The chi-square statistic is insignificant ($p=.065$), suggesting an inability to reject the proposed model, while the RMSEA statistic is .029, below the typical .05 guideline.

--- Figure 2 About Here ---

Reliabilities for the scales are given in the Measurement Appendix. All exceed the 0.6 guideline for composite reliability (Bagozzi and Li 1996). We assess discriminant validity by constraining each inter-trait correlation to unity and examining differences in chi-square values between constrained and unconstrained models. All test statistics are significant ($p < .05$), suggesting discriminant validity.

Estimation

Descriptive statistics and zero-order correlations for the variables are shown in Table 1. The empirical estimation involves two equations, one predicting contractor property rights and the other predicting contractor opportunism:

$$\text{Contractor IPR} = \alpha_0 + \alpha_1 \text{ Client Specificity} + \alpha_2 \text{ Market Uncertainty} + \alpha_3 \text{ Technical Uncertainty} + \alpha_4 \text{ Outside Applications} + \alpha_5 \text{ Available Suppliers} + \alpha_6 \text{ Contractor Investment} + \alpha_7 \text{ Task Creativity} + \alpha_8 \text{ Client Skills} + v.$$

$$\text{Contractor Opportunism} = \beta_0 + \beta_1 \text{ IPR} + \beta_2 \text{ Client Specificity} + \beta_3 \text{ IPR} \cdot \text{ Client Specificity} + \beta_4 \text{ Market Uncertainty} + \beta_5 \text{ IPR} \cdot \text{ Market Uncertainty} + \beta_6 \text{ Technical Uncertainty} + \beta_7 \text{ IPR} \cdot \text{ Technical Uncertainty} + \beta_8 \text{ Contractor Investment} + \varepsilon.$$

--- Table 1 About Here ---

Recall that contractor IPRs are set with an eye toward maximizing their expected net benefits, which are in part a function of opportunism. To correct for this self-selection, we employ the two-step estimator presented by Garen (1984) which also controls for unobserved heterogeneity associated with different levels of the choice variables. The first step requires estimation of the contractor IPR equation above. The second step requires estimation of the following augmented equation:

$$\text{Contractor Opportunism} = \beta_0 + \beta_1 \text{ IPR} + \beta_2 \text{ Client Specificity} + \beta_3 \text{ IPR} \cdot \text{ Client Specificity} + \beta_4 \text{ Market Uncertainty} + \beta_5 \text{ IPR} \cdot \text{ Market Uncertainty} + \beta_6 \text{ Technical Uncertainty} + \beta_7 \text{ IPR} \cdot \text{ Technical Uncertainty} + \beta_8 \text{ Contractor Investment} + \beta_9 \hat{v}^+ + \beta_{10} \hat{v}^+ \cdot \text{IPR} + \beta_{11} \hat{v}^- + \beta_{12} \hat{v}^- \cdot \text{IPR} + \varphi.$$

Here, \hat{v}^+ denotes the positive residuals and \hat{v}^- the negative residuals from the contractor IPR equation.

The error term, φ , in this equation will be heteroskedastic, thus we employ White's (1980)

heteroskedastic-consistent GLS estimator. We also use GLS in the contractor IPR equation as a

precaution, since approximately one-fourth of the cases in our sample report the minimum possible

contractor property rights (i.e., a value of 1.0 on the scale) and it is possible that this group of

observations might exhibit other idiosyncratic traits resulting in non-independence among the residuals.

As a stronger accommodation, we examine the robustness of our estimates with a tobit model, discussed

below. All estimation is carried out in Stata 8.

Contractor IPR Estimates

Estimates for the contractor IPR model are presented in the first column of Table 2. The key hypotheses are that contractor IPRs will increase in (a) the specificity of the client's investments, (b) market uncertainty, (c) technical uncertainty, and (d) the extent of outside applications of the technology.

More specific investments by the client exhibit the expected positive and significant coefficient, supporting Hypothesis 1. In contrast, neither market uncertainty nor technical uncertainty show a significant relationship with contractor IPRs, failing to support Hypothesis 2. While we consider alternative model specifications to account for this shortcoming below, insignificant findings for uncertainty are not necessarily surprising in the light of the empirical evidence to date; the predicted governance effects of uncertainty have received at best mixed support (e.g., David and Han 2004). In our case, we speculate that shocks might not be a necessary condition for opportunism since bargaining over quasi-rents can be initiated at any time given incomplete contracts. Finally, we find a highly significant and positive coefficient for the extent of outside applications, supporting Hypothesis 3.

Turning to the control variables, we find that the number of available suppliers exhibits the expected negative coefficient, while task creativity is positively related to contractor IPRs. We also find a significant positive association between the contractor's investment and contractor IPRs. Client skills, in contrast, do not have a significant effect on contractor IPRs.

--- Table 2 About Here ---

Robustness Checks

Estimates from the tobit model appear in the second column of Table 2. The tobit model applies a likelihood function that simultaneously predicts whether an observation will fall outside the “zero” category (in this case the minimum score of 1.0 for contractor IPRs) and the extent of contractor property rights, should the observation fall outside the category. The results are virtually identical.

In addition, although we offered main-effect hypotheses, it is possible that the key variables in the model interact with one another in determining governance. First, uncertainty is often hypothesized to matter only in conjunction with specificity. While our specification is consistent with this proposition as long as specificity is non-zero on average (Williamson 1985, p. 60), an alternative is to interact the uncertainty variables with specificity. Second, outside applications play a key role in creating an arbitrage opportunity in our theory. Hence it is possible that the specificity and uncertainty variables interact with the extent of outside applications to determine governance, although as above our specification is

consistent as long as outside applications are non-zero on average. A model containing both sets of interactions is presented in the third column of Table 2 (we also examined each set individually and repeated the analysis in the tobit model and found similar results). The interactions are all insignificant and the other coefficients are materially unchanged. Hence, while the logic of interactions makes considerable sense, the data strongly favor main-effect relationships as hypothesized.

Contractor Opportunism Estimates

Selection corrected contractor opportunism estimates are given in Table 3.⁹ Here and in our robustness checks above we mean-centered the variables prior to computing multiplicative interactions to allow meaningful interpretation of the main effects. We find support for Hypothesis 4 in the significant negative coefficient for contractor IPRs. Similarly, Hypothesis 5 is supported by the significant positive coefficient for the specificity of the client’s investment. Of the two coefficients corresponding to Hypothesis 6, we find an insignificant coefficient for the market uncertainty measure, but find the predicted positive coefficient for technical uncertainty. Hypothesis 7 is supported by the significant negative coefficient for the interaction of contractor property rights and specificity. Examining the two coefficients for the uncertainty interactions relevant to Hypothesis 8, we find a significant negative coefficient for the interaction of market uncertainty and contractor property rights as predicted, but an insignificant coefficient for the interaction of technical uncertainty and contractor property rights. Finally, we find that contractor investment has no significant effect on contractor opportunism. We also extracted the residuals from the tobit model and used them in the second-stage selection correction procedure and found the results to be materially unchanged.

--- Table 3 About Here ---

In order to describe the main and interaction effects involving contractor IPRs in a more intuitive fashion, we plot the partial derivatives of contractor opportunism with respect to specificity and market uncertainty over a range of contractor IPRs in Figure 3. These are labeled $\frac{\partial OPPORTUNISM}{\partial CS}$ and

$\frac{\partial OPPORTUNISM}{\partial MARKET}$ respectively. The first plot shows that more specific investments by the client increase

contractor opportunism everywhere, but at a smaller rate with more contractor property rights, illustrating the safeguarding effect. Similarly, market uncertainty has a diminished effect on contractor opportunism with more contractor property rights, again showing the safeguarding effect.

--- Figure 3 About Here ---

The contractor opportunism equation also includes four additional variables that are intended to correct for the self-selection of IPRs. The coefficient of $\hat{\nu}^+$ is significant, indicating a significant selection bias that was corrected in the estimation. The positive sign of the coefficient of $\hat{\nu}^+$ gives us further insight. A large value of $\hat{\nu}^+$ corresponds to a client that has granted its contractor unexpectedly high property rights. The positive coefficient means that such a firm faces higher contractor opportunism. Consider this result in conjunction with our coefficient supporting Hypothesis 4 that granting more contractor property rights reduces contractor opportunism (i.e., at the levels of contractor IPRs self-selected by the clients). It means that contractors do not become more charitably predisposed or bond themselves closer to the client upon getting windfall gains in property rights. This distinguishes our calculative explanation for the selection of property rights from social cohesion or equity arguments that greater sharing of outputs produce more cooperative relationships per se.

DISCUSSION

The results suggest that clients can use IPRs as safeguards against contractor opportunism during the performance of outsourced RD&E work. Clients are observed to share IPRs more liberally as their investments become more transaction specific. When using IPRs as safeguards, clients should opt to sacrifice value outside intended fields-of-use for more efficient development within intended applications. Consistent with this idea, clients are shown to share more IPRs when there are applications of the technology outside their intended fields-of-use. They also share rights more liberally for creative tasks, where client-control is likely to be most detrimental. Moreover, in our secondary investigation, contractor property rights are shown to act as safeguards both in their main effect and by reducing the magnitude of relationships between specificity and market uncertainty on the one hand and contractor opportunism on

the other. Strategically, the results suggest a way that clients can avoid costly internalization of RD&E activities by sharing less valuable rights outside their intended uses to create necessary safeguards while still benefiting from the efficiencies of outsourcing in their intended applications. The positive externality created by outside applications means that the client can share IPRs and do better in the bargaining from the perspective of its key areas of interest.

Our approach differs from most transaction cost analyses of interorganizational governance in that it recognizes the dependence balancing role of contractor IPRs and their effect on ex post bargaining power. While it is generally accepted that property rights strengthen incentives for task performance in general, conventional logic would suggest that a contractor granted a share of property rights would bargain just as aggressively over the remaining surplus ex post. Hence, granting property rights would seem to reward the contractor by securing for it certain rents while doing little to curb opportunistic bargaining over remaining quasi-rents. We offer a different hypothesis due to the way IPRs balance dependence in the relationship and reduce the ex post bargaining position of the contractor.

In addition, we expand on the dependence balancing and property rights literatures by recognizing the positive economic externality created by uses of the technology not targeted by the client. While the dependence balancing literature is too nascent for meaningful comparisons, the maintained assumption in PRT is that complementary assets are valuable only in a single field-of-use. As illustrated above, this assumption conflicts with the ground realities in many technology development relationships.

While our focus in this study is on sponsored RD&E relationships, many aspects of the analysis have implications for hybrid organizations more generally. Equity-sharing alliances, joint ventures, franchise arrangements and other hybrids involve the allocation of property rights between independent parties to align incentives and protect specific investments; hence, many of the governance issues are comparable. The study of Michael (2000) perhaps comes closest to this investigation in that it examines the effect of tapered integration on franchisor bargaining power. The traditional analysis of hybrid forms suggests that they are characterized by intermediate levels of coordination and incentive intensity in comparison to markets and hierarchies (Williamson, 1991). Thus, they are less (more) prone to

opportunism and better (less) able to adapt in a coordinated manner than markets (hierarchies), but with weaker (stronger) performance incentives and a poorer (better) ability to adapt autonomously. Our analysis is similar in that contractors vested with IPRs are less inclined to bargain during cooperative adaptation than those without IPRs (the “market” mode). However analyses of hybrid organization require extra emphasis on what Williamson calls the process particulars associated with the context. Vested contractors face weaker incentive intensity in the sense that they are less inclined to bargain for private gains than contractors without IPRs, but their incentives to invest effort autonomously are higher. Since outsourcing allows the client to benefit from the general cost savings associated with avoiding internal organization, outsourcing to vested contractors is a relatively attractive governance mode conditioned on the availability of IPRs outside intended uses of the client.

Revised Comparative Governance Schema

We summarize our approach to governance design and integrate it with the extant literature in the revised governance schema presented in Figure 4. Consistent with Williamson (1985), relationships involving limited specific investments are efficiently governed through market exchange with safeguarding provided by the threat of costless or low-cost replacement. Relationships involving specific investments (beyond some threshold) warrant non-market safeguards, of which ex ante contracts are the default option. However, contracts grow increasingly inefficient as uncertainty increases, prompting the use of alternative governance mechanisms. Control, executed through internal organization or quasi-integrated forms, is optimal when the task does not require a high degree of creativity and/or the technology is valuable only within the client’s intended field(s)-of-use. In the latter case, there is no arbitrage opportunity to share less valuable IPRs in exchange for safeguarding; hence control is the only viable safeguard. In contrast, as the task becomes more creative and the technology has greater applicability beyond the client’s intended field(s)-of-use, safeguarding via IPRs becomes more attractive. As discussed above, RD&E relationships generally involve specific investments, uncertainty, and creativity, suggesting a role for IPR sharing conditioned on the existence of uses for the technology in areas not targeted by the client.

--- Figure 4 About Here ---

Limitations and Future Research

The theory and empirical test presented in this paper suffer from a number of limitations that we discuss in this section. Most importantly, the study suffers from data limitations. We used psychometric measures collected from only the client-side of the dyad. The validity of the individual items and scales is less than perfect and our measures may be biased by idiosyncrasies in how the client views the relationship. A better design would obtain measures from both sides of the dyad and use either grounded and archival measures or a mixed measurement approach. In the study, IPRs might be better measured by observing explicit contractual clauses rather than by questionnaire scales. This might also allow better empirical (and theoretical) discrimination between the various aspects of IPRs and their functioning. For example, how do ownership rights created by patent differ from usage rights assigned by a potentially incomplete contract? The opportunism scale is also noteworthy, as it includes a number of items that we interpret as indicators of opportunism, but which may in part reflect legitimate or expected business practices, and may be colored by asking the client rather than the contractor. For example, the escalation of cost estimates may be due to input price increases, or contractors may resist changes due to the client's misunderstanding of the best way to proceed rather than bargaining. Moreover, we lack a client opportunism measure which might indicate that conflict originated in the actions of the client rather than those of the contractor. The client may also systematically underestimate the contractor's investment or over-estimate the specificity of its own investment. Other data limitations include the sampling procedure, which only approximates a random sample of sponsored outsourced development projects.

In terms of the theory, while we tried to fit the empirical context, we may also have left behind some depth of rigor developed within the base areas. In particular, there are now many variants of property rights models that make quite nuanced predictions. In addition, omitted variables may bring unanticipated surprises. We do not account for the price charged for the contractor's work in our theory, and we have also ruled out efficiency-improving side-payments and transfers (other than through bargaining) due to our assumption of incomplete contracts. Similarly, reputations do not play a major role

in our theory, although we recognize the costs associated with engaging in opportunistic behavior due in part to damage to reputations. In essence, we approach the problem in this study from a perspective where reputations do not eliminate contracting hazards due to imperfect information. Moreover, our cross-sectional empirical test makes it difficult to discern the causality of relationships with precision. Longitudinal and experimental research would seem well suited to testing the basic claim that IPRs reduce contractor tendencies toward opportunism.

One potential criticism of our arguments is that IPR sharing might lead to unacceptable levels of technology leakage if IPRs, and particularly field-of-use restrictions, were not contractible, in contrast to our assumptions. This is a particularly germane issue given the emphasis in the practitioner literature on the liabilities associated with technology leakage and the desirability of exclusive property rights. While we agree that leakage is inevitably a concern, if IPRs were non-contractible, *any* outsourced relationship would result in unacceptable leakage regardless of attempts by the client to retain IPRs, exclusive or otherwise. Hence, we would expect little if any outsourced RD&E in practice. However, there is strong anecdotal evidence from industry data and the legal field that IPRs and field-of-use restrictions are contractible, even if imperfectly so.

Indeed, there are opportunities for future research to examine some of these issues. In addition to the strength of the property rights regime, we would expect characteristics of the technology and the client to matter. For example, a client firm in an oligopolistic market featuring greater product differentiation (e.g., automobiles) might be more reluctant to hire a contractor for fear that spillover of its plans or intellectual property to its competitors would reduce its margins. Such a powerful firm might well trade off prospective outsourcing efficiency gains to protect its incumbent margins (Ghosh and John, 1999; Shervani, Frazier, and Challagalla, 2007). The current analysis could be extended to incorporate this concern.

Another attractive avenue for future work is stronger empirical evidence about the performance implications of rights sharing. Although the underlying behavior in our theory is explicitly intended to maximize returns, very little evidence exists about the size and direction of these effects on revenues

and/or costs. It would be useful to supplement our ex post opportunism measure with cost and/or profit data to examine whether the behaviors and safeguarding effects observed in this study impact firm profitability.

REFERENCES

- Aghion, Philippe and Jean Tirole (1994), "The Management of Innovation," *Quarterly Journal of Economics*, 109 (November): 1185-1209.
- Alchian, Armen and Harold Demsetz (1972), "Production, Information Costs, and Economic Organization," *American Economic Review*, 62 (December): 777-795.
- Amabile, Teresa, M., Regina Conti, Heather Coon, Jeffrey Lazenby, and Michael Herron (1996), "Assessing the Work Environment for Creativity," *Academy of Management Journal*, 39 (October), 1154-84.
- Anderson, Erin (1985), "The Salesperson as Outside Agent or Employee: A Transaction Cost Analysis," *Marketing Science*, 4 (Summer): 234-254.
- Bagozzi, Richard P. and Youjae Yi (1988), "On the Evaluation of Structural Equation Models," *Journal of the Academy of Marketing Science*, 16 (Spring): 74-95.
- Bajari, Patrick and Steve Tadelis (2001), "Incentives versus Transactions Costs: A Theory of Procurement Contracts", *Rand Journal of Economics*, 32 (Autumn): 387-407.
- Banerjee, Abhijit V. and Esther Duflo (2000), "Reputation Effects and the Limits of Contracting: A Study of the Indian Software Industry", *Quarterly Journal of Economics*, 115 (August): 989-1017.
- Barzel, Yoram (1982), "Measurement Cost and the Organization of Markets," *Journal of Law and Economics*, 25 (April): 27-48.
- Cheung, Steven N. S. (1968), "Private Property Rights and Sharecropping," *Journal of Political Economy*, 76 (November-December): 1107-1122.
- Cheung, Steven N. S. (1969), "Transaction Costs, Risk Aversion, and the Choice of Contractual Arrangements," *Journal of Law and Economics*, 12 (April): 23-42.
- Chi, Tailan (1994), "Trading in Strategic Resources: Necessary Conditions, Transaction Cost Problems, and Choice of Exchange Structure," *Strategic Management Journal*, 15: 271-290.
- Clarkson, Kenneth W., Roger LeRoy Miller, Gaylord A. Jentz, and Frank B. Cross (1989), *West's Business Law*, 4th Ed. St. Paul, MN: West Publishing Company.
- Crocker, Keith J. and Kenneth J. Reynolds (1993), "The Efficiency of Incomplete Contracts: An Empirical Analysis of Air Force Engine Procurement", *Rand Journal of Economics*, 24 (1): 126-146.

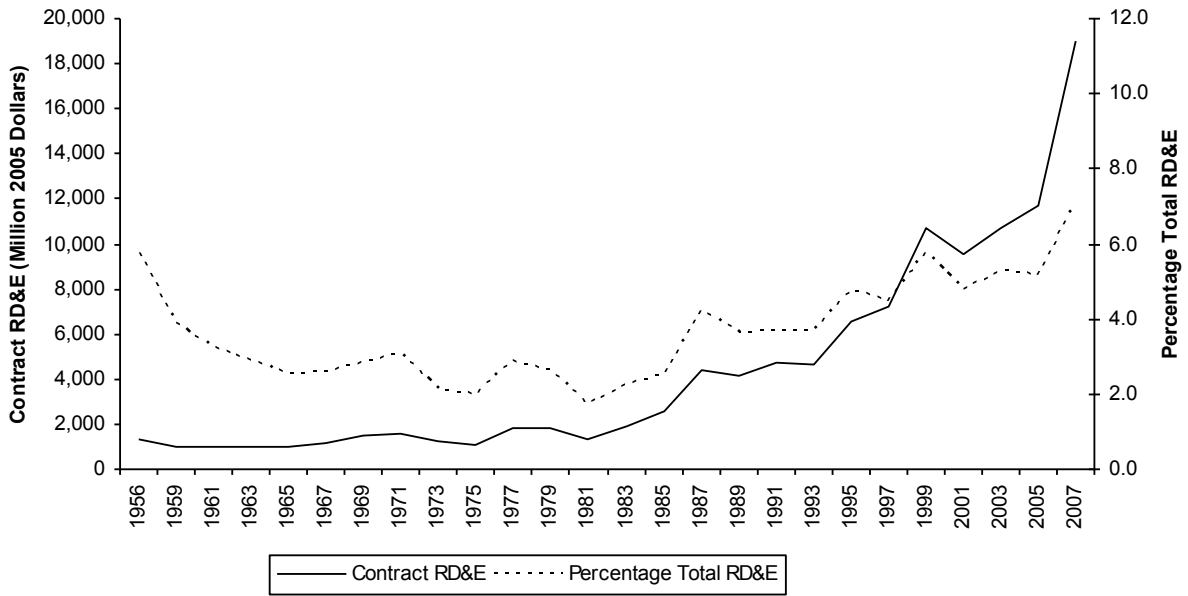
- Damanpour, Fariborz (1991), "Organizational Innovation: A Meta-Analysis of Effects of Determinants and Moderators," *Academy of Management Journal*, 34 (3): 555-590.
- Demsetz, Harold (1967), "Toward a Theory of Property Rights," *American Economic Review*, 57 (May): 347-359.
- David, R. J. and S. Han (2004), "Assessment of the Empirical Support for Transaction Cost Economics," *Strategic Management Journal*, 25, 39–58.
- Furubotn, Eirik Grundtvig and Svetozar Pejovich (1974), *The Economics of Property Rights*. Cambridge, MA: Ballinger.
- Garen, John (1984), "The Returns to Schooling: A Selectivity Bias Approach with a Continuous Choice Variable," *Econometrica*, 52 (September): 1199-1218.
- Ghosh, Mrinal and George John (1999), "Governance Value Analysis and Marketing Strategy," *Journal of Marketing*, 63 (December): 131-145.
- Grossman, Sanford J. and Oliver D. Hart (1986), "The Costs and Benefits of Ownership: A Theory of Vertical and Lateral integration," *Journal of Political Economy*, 94 (4): 691-719.
- Hamilton, Barton H. and Jackson A. Nickerson (2003), "Correcting for Endogeneity in Strategic Management Research," *Strategic Organization*, 1 (February): 51-78.
- Hart, Oliver (1995), *Firms, Contracts, and Financial Structure*. Oxford: Oxford University Press.
- Hart, Oliver and John Moore (1990), "Property Rights and the Nature of the Firm," *Journal of Political Economy*, 98 (December): 691-719.
- Hauser, John R. and Florian Zettlemeyer (1996), "Metrics to Evaluate RD&E," Working Paper 3934-96, International Center for Research on the Management of Technology, Sloan School of Management, Massachusetts Institute of Technology.
- Heide, Jan B. (1994), "Inter-organizational Governance in Marketing Channels," *Journal of Marketing*, 52 (January): 71-85.
- Heide, Jan B. and George John (1988), "The Role of Dependence Balancing in Safeguarding Transaction Specific Assets in Conventional Channels," *Journal of Marketing Research*, 27 (February): 20-35.
- Holmes, Oliver Wendell (1881/1946), *The Common Law*, Reprint. Boston: Little, Brown.

- Jarvis, Cheryl Burke, Scott B. MacKenzie, and Philip M. Podsakof (2003), "A Critical Review of Construct Indicators and Measurement Model Misspecification in Marketing and Consumer Research," *Journal of Consumer Research*, 30 (September): 119-218.
- John, George (1984), "An Empirical Examination of Some Antecedents of Opportunism in a Marketing Channel," *Journal of Marketing Research*, 21 (August): 278-289.
- Klein, Benjamin (1996), "Why Hold-Ups Occur: The Self-Enforcing Range Of Contractual Relationships," *Economic Inquiry*, 34(3): 444-463.
- Klein, Benjamin, R. A. Crawford, and A. A. Alchian (1978), "Vertical Integration, Appropriable Rents, and the Competitive Contracting Process," *Journal of Law and Economics*, 21 (October): 297-326.
- Knight, Frank (1965), *Risk, Uncertainty, and Profit*. New York: Harper & Row.
- Lerner, Josh and Ulrike Malmendier (2005), "Contractibility and the Design of Research Agreements," NBER Working Paper No. 11292.
- Lerner, Josh, Hilary Shane, and Alexander Tsai (2003), "Do Equity Financing Cycles Matter? Evidence from Biotechnology Alliances," *Journal of Financial Economics*, 67 (3): 411-446.
- Levin, Richard C., Alvin K. Klevorick, Richard R. Winter, and Sidney J. Nelson (1987), "Appropriating the Returns from Industrial Research and Development," *Cowles Foundation Paper*, No. 714. New Haven: Cowles Foundation.
- Majewski, Susan E. and Dean V. Williamson (2002), "Endogenous Spillovers, Strategic Blocking, and the Design of Contracts in Collaborative R&D: Evidence from NCRA Filings of R&D Joint Ventures," Economic Analysis Group Discussion Paper: EAG 02-1. Available at SSRN: <http://ssrn.com/abstract=307459> or doi:10.2139/ssrn.307459.
- Masten, Scott E. (1993), "Transaction Costs, Mistakes, and Performance: Assessing the Importance of Governance," *Managerial and Decision Economics*, 14: 119-129.
- Masten, Scott E., James W. Meehan, Jr., and Edward A. Snyder (1991), "The Costs of Organization," *Journal of Law, Economics, and Organization*, 7 (1): 1-25.
- Michael, Steven C. (2000), "Investments to Create Bargaining Power: The Case of Franchising," *Strategic Management Journal*, 21: 497-514.

- Milgrom, Paul and John Roberts (1992), *Economics, Organization, and Management*. Englewood Cliffs, NJ: Prentice-Hall.
- Montoya-Weiss, Mitzi M. and Roger Calantone (1994), "Determinants of New Product Performance: A Review and Meta-Analysis," *Journal of Product Innovation Management*, 11 (5): 397-418.
- Moorman, Christine and Anne S. Miner (1997), "The Impact of Organizational Memory on New Product Performance and Creativity," *Journal of Marketing Research*, 24 (February): 91-108.
- Nash, John F, Jr. (1950), "The Bargaining Problem," *Econometrica*, 18, 155-162.
- NSF, The National Science Foundation (2011), Survey of Industrial Research and Development. Accessed September 16, 2011 [available at http://www.nsf.gov/statistics/iris/history_pub.cfm].
- Pisano, Gary P. (1990), "The R&D Boundaries of the Firm: An Empirical Analysis," *Administrative Science Quarterly*, 35 (1): 153-176.
- Robinson, David T. and Toby E. Stuart (2003), "Contractual, Relational, and Property Rights-based Control in Biotech Strategic Alliances," *Duke University Working Paper*.
- Sherbloom, James P. (1991), "Ours, Theirs, or Both? Strategic Planning and Deal Making," in *The Business of Biotechnology: From the Bench to the Street*, R. Dana Ono ed. Stoneham, Massachusetts: Butterworth-Heineman, 213-224.
- Shervani, Tasadduq A., Gary Frazier, and Goutam Challagalla (2007), "The Moderating Influence of Firm Market Power on the Transaction Cost Economics Model: An Empirical Test in a Forward Channel Integration Context," *Strategic Management Journal*, 28 (June), 635-652.
- Spier, Kathyryne E. (1992), "Incomplete Contracts and Signaling," *Rand Journal of Economics*, 23(3): 432-443.
- Teece, David J. (1988), "Technological Change and the Nature of the Firm," in *Technical Change and Economic Theory*, Giovanni Dosi, Christopher Freeman, Richard Nelson, Gerald Silverberg, and Luc Soete, eds. London: Pinter.
- Teece, David J. (2000), *Managing Intellectual Capital*. Oxford: Oxford University Press.
- Tirole, Jean (2009), "Cognition and Incomplete Contracts," *American Economic Review*, 99 (March): 265-294.
- Ulset, Svein (1996), "R&D Outsourcing and Contractual Governance: An Empirical Study of Commercial R&D Projects." *Journal of Economic Behavior and Organization*, 30 (1): 63-82.

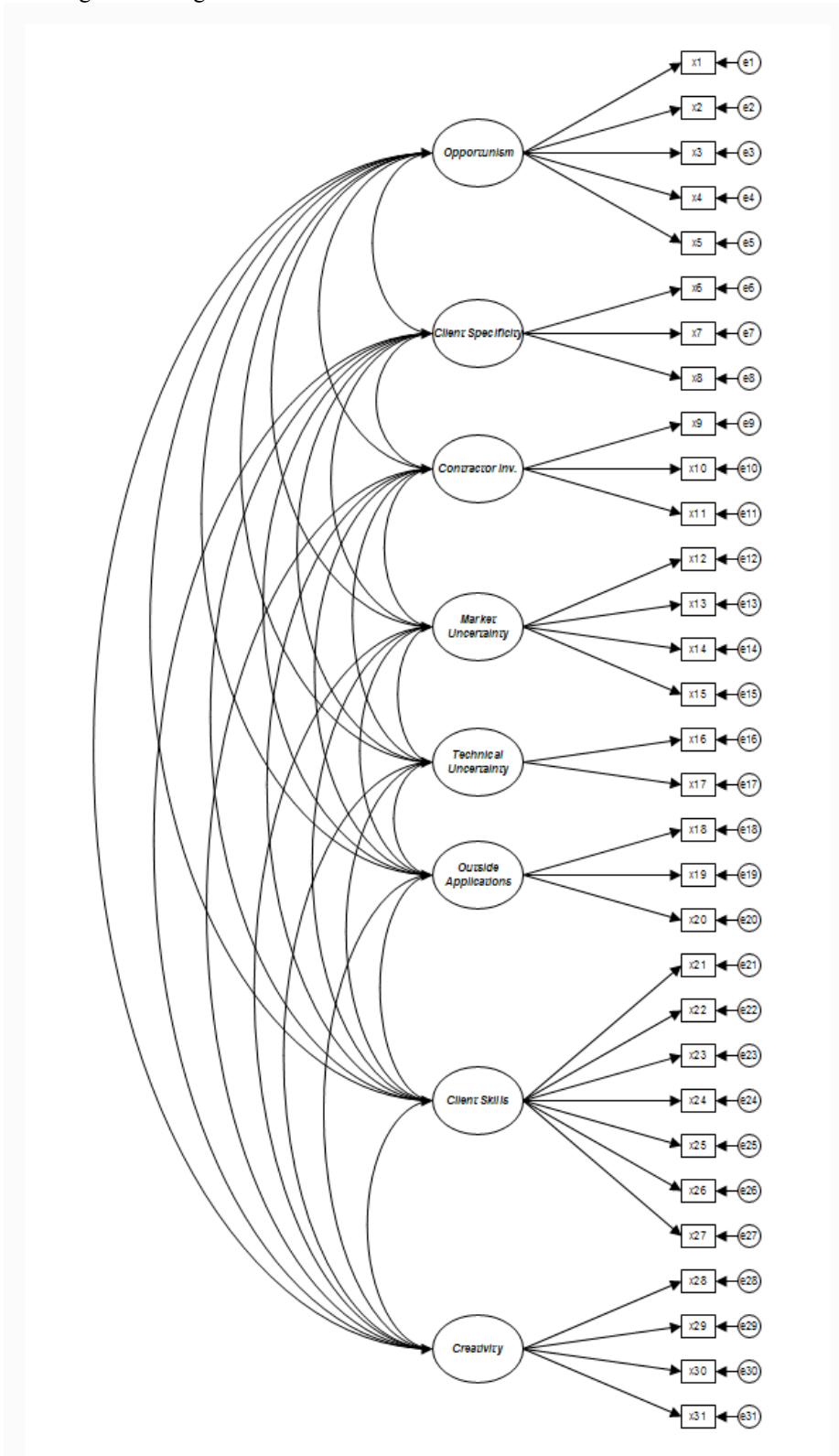
- Whinston, Michael D. (2003), "On the Transaction Cost Determinants of Vertical Integration," *Journal of Law, Economics, and Organization*, 19(1): 1-23.
- White, H. (1980), "A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity," *Econometrica*, 48 (May): 817-838.
- Williamson, Oliver E. (1983), "Credible Commitments: Using Hostages to Support Exchange," *American Economic Review*, 73 (September): 519-40.
- Williamson, Oliver E. (1985), *The Economic Institutions of Capitalism: Firms, Markets, and Relational Contracting*. New York: The Free Press.
- Williamson, Oliver E. (1991), "Comparative Economic Organization: The Analysis of Discrete Structural Alternatives," *Administrative Science Quarterly*, Vol. 36 (2): 269-296
- Williamson, Oliver E. (1996), *The Mechanisms of Governance*. Oxford: Oxford University Press.

Figure 1. Non-Federally Funded RD&E by U.S. Firms Contracted to Outside Organizations, 1956-2007*



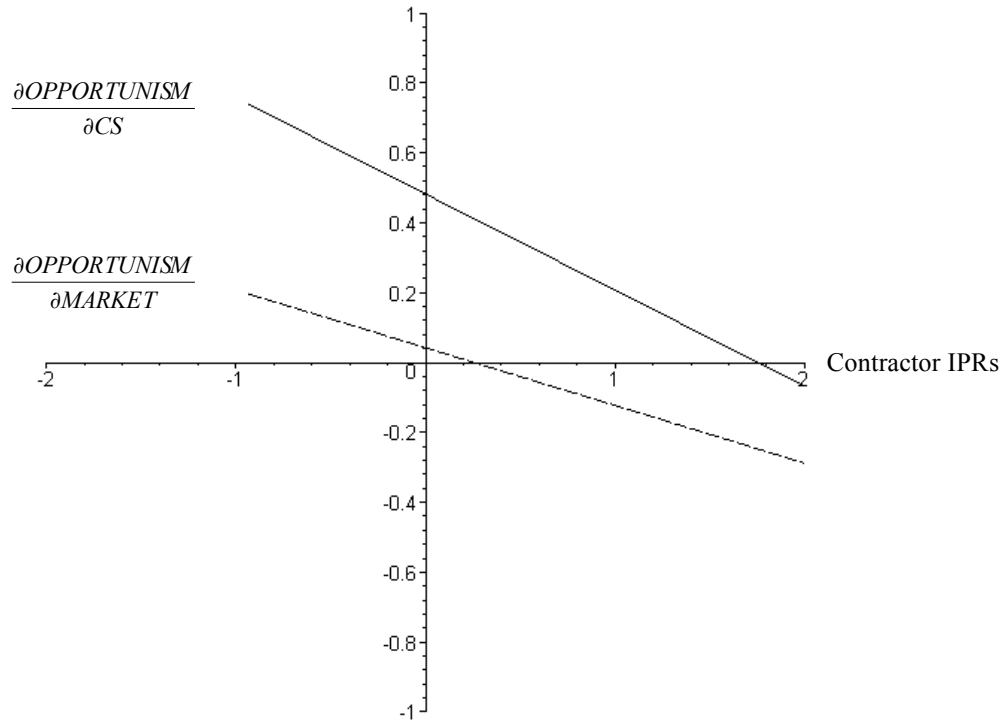
*Excludes RD&E contracted to organizations outside the US.

Figure 2. Congeneric Measurement Model for Multi-Item Reflective Scales



Model Fit Statistics: $\chi^2(406)=449.917$, $p=.065$; GFI=.832; NFI=.844; IFI=.982; RMSEA=.029; Probability RMSEA \leq .05=.994.

Figure 3. Effects of Client Specificity and Market Uncertainty on Contractor Opportunism over Range of Contractor Property Rights*



* Contractor IPRs plotted from the minimum value to two standard deviations above the mean. Only slope of graph is significant for market uncertainty.

Figure 4. Revised Comparative Governance Schema

