

**WHO I AM AND HOW I CONTRACT: THE EFFECT OF CONTRACTORS'  
ROLES ON THE EVOLUTION OF CONTRACT STRUCTURE IN  
UNIVERSITY-INDUSTRY RESEARCH AGREEMENTS**

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Abstract

In this exploratory study of university-industry sponsored research agreements, we investigate how organizational roles direct relational learning of contracting personnel, which subsequently impacts contract evolution. Integrating theory with comments from field interviews, we posit that as scientists gain contracting experience with an exchange partner their focus of attention on knowledge creation supports the establishment of a relationship based on technical competence, behavioral experience, and operational routines that cause the enforcement terms of subsequent contracts to become less detailed. We also submit that contract administrators, because of their focus on knowledge protection (mitigating opportunism and enforcement), primarily accumulate joint governance experience and establish administrative routines which cause the enforcement terms of subsequent contracts to become more detailed. Rich content analysis of monitoring and intellectual property terms of sponsored research agreements supports our theoretically-grounded hypotheses.

**Key Words for Paper:** Contract Evolution, Organizational Roles, Sponsored Research Agreements

With the enhanced breadth and depth of knowledge required for innovation, corporations no longer are able to limit their search for relevant knowledge to internal sources (Ahuja, 2000; Cohen & Levinthal, 1990). Accordingly, many firms are establishing cross-boundary relationships to access the expertise of researchers at external organizations (Chesbrough, 2003). Determining the appropriate contract structure, and adapting the terms of the agreement as these relationships evolve, is an important contributor to success in such inter-organizational activities (Arino & de la Torre, 1998; Sampson, 2004). Getting the contract right is challenging, however, as cross-boundary innovation-based relationships generally involve multiple decision-makers in different organizational roles, each with the power to influence the provisions and terms included in a contractual agreement (Daft, 1978; Ring & Van de Ven, 1994). Our understanding of how these multiple decision-makers differentially impact contract design and evolution is currently limited.

This study explores how contracts governing corporate sponsored research relationships reflect relational learning between contracting personnel based on their organizational roles. Applying behavioral theory logic, we posit that different organizational roles, because of their associated goals, knowledge sets and incentives, focus attention on different aspects of the contracting process and on different contractual elements (Cyert & March, 1963; March & Simon, 1958). In turn, these organizational roles learn different things as they gain contracting experience with an exchange partner. Integrating comments from field interviews with theory, we posit that as scientists gain contracting experience with an exchange partner, their focus of attention on knowledge creation supports the reduction of technical and behavioral uncertainty and the emergence of operational routines, causing subsequent contracts to become less detailed (Gulati, 1995; Lumineau & Oxley, 2012). We also propose that contract administrative personnel, who are responsible for managing the contracting process for their organization, focus their attention on knowledge protection associated with mitigating opportunism and ensuring enforcement. We suggest this attention focus causes contract administrators to primarily

accumulate joint governance experience and establish negotiation routines which cause subsequent contracts to become more detailed (Daft, 1978; March 1994; Reitzig & Puranam, 2009).

Our study makes two main contributions to the contracting literature: it delineates the learning mechanisms that result in additions and deletions of contracting terms by contract administrators and scientists respectively, and it presents the first empirical test of directional impacts of multiple organizational roles on contract design. More specifically, this study extends contracting theory by delineating how the goals of different organizational roles focus participants' attention to different aspects of the contract and contracting process. These different foci leads to differences in the learning processes experienced by contract administrators and scientists prompting additions and deletions, respectively, as evidence of learning in sponsored research relationships. While the potential importance of different organizational types or groups has been raised in earlier contract work, in this study we use the term organizational role as it is used in behavioral theory (Cyert & March, 1963; March & Simon, 1958; Simon, 1947) to describe the task, job or structural position held by contract participants within a particular organization. Furthermore, we provide the first empirical test of simultaneous, directional impacts of multiple organizational roles on contract design. Contracting research has previously found directional effects but these studies did not consider the organizational roles involved in contracting (Reuer & Arino, 2007; Ryall & Sampson, 2009). The research that has theorized about which types are the primary repositories for particular contract terms have taken a more qualitative approach (Argyres & Mayer, 2007; Mayer & Argyres, 2004). We content analyze 136 contracts randomly selected from a stratified population of contracts between a major university and corporate research sponsors, enabling the use of multivariate empirical techniques in hypotheses testing.

Our study of a sponsored research context is novel and at the same time generalizable. It is novel in that contracting studies seldom investigate contracting between not-for-profit organizations and for-profit corporations. Similarly, the influence of scientists, who are essential to the innovation process and are often actively involved in designing technology exchange agreements, is understudied. It is generalizable in that the conceptual insights regarding role-based directional learning and contract

design, though drawn from an investigation of contract administrators and scientific personnel engaged in the development and negotiation of sponsored research activities, have relevance for other contexts where multi-point contacts jointly negotiate cross-boundary agreements. In addition, our content analysis of contracts allows us to report detailed measures of monitoring and intellectual property rights provisions, which provides a rich understanding of how contracts are specified. These detailed measures allow us to empirically investigate the relative influence of different contracting parties as previously postulated in the contracting literature but not yet tested. For example, Argyres & Mayer (2007) develop several propositions about which organizational types (managers, engineers, or lawyers) will serve as the more significant repositories of different categories of contract design capabilities and are thus anticipated to play a larger part in the specification of the related contract terms. Although our study focuses on scientists and contract administrators, relational learning, and directional impact, our detailed larger sample data allows us to present empirical insights related to these propositions.

We begin by reviewing the relevant literature, presenting the context of our study, and developing our hypotheses. Next, we describe our data and methods, and explain our results. We conclude by discussing the implications and limitations of the study and directions for future research.

## **THEORETICAL BACKGROUND, STUDY CONTEXT, AND HYPOTHESIS DEVELOPMENT**

### **Relational Learning, Organizational Roles, and Contract Structure**

The relational learning literature has posited two distinct forms of learning related to partner-specific relationships – learning about: (1) exchange partner beliefs and expected behavior, and (2) operational and administrative routines and advantageous inter-organizational practices. The contracting literature has found evidence of these forms of learning (Anand & Khanna, 2000; Ring & van de Ven, 1992), and extended them to include learning how to contract (Mayer & Argyres, 2004). First, through repeated interactions, transacting partners are able to lower the technical and behavioral uncertainty associated with cross-boundary innovation efforts. Through an initial project, exchange parties can gain a deeper understanding of the technological challenges and potential implications of the project (Hicks, 1995). Further, through on-going interactions, trust or mutual norms and feelings of affiliation may form

as transacting partners gain familiarity with one another, build personal ties, and generate confidence in the goodwill of their partner (Gulati, 1995; Gulati & Nickerson, 2008). In this respect, relational learning serves as a means to deal with both behavioral and technical uncertainty in inter-organizational relationships. Second, through repeated interactions, partners can develop an enhanced understanding of the operational and administrative procedures, organizing systems, and problem-solving processes of their partner (Faems et al., 2008). Based on this relationship-specific knowledge, the exchange partners can then devise and refine inter-organizational routines that have the potential to smooth interaction patterns and raise exchange efficiency (Dyer & Singh, 1998; Zollo et al., 2002). More recently, contract research has focused on a particular type of administrative routine, the refinement of contracting capabilities (Mayer & Argyres, 2004; Ryall & Sampson, 2009). This research holds that repeated contracting raises awareness of potential exchange issues and alternative contracting safeguards. With greater exposure to a range of scenarios, the partners may enhance their toolbox of governance solutions (Argyres et al., 2007; Argyres & Mayer, 2007).

Against this backdrop, research has explored the effect of prior partner-specific transacting experience and relational learning on the structure of contract terms (i.e., explicitness) used to govern subsequent transactions between partners (Gulati, 1995; Reuer & Arino, 2007; Ryall & Sampson, 2009). Empirical results have been mixed, in some cases showing a positive relationship between prior partner-specific experience and contract explicitness and in other cases showing a negative relationship. A better understanding of the factors underlying these different outcomes is needed. In their study of contract design capabilities, Argyres and Mayer (2007) offer an insight that we believe is pertinent to this issue hypothesizing that such capabilities reside differentially in different kinds of employees.<sup>1</sup> While they do not discuss the direction of influence, their reasoning raises the potential importance of organizational

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<sup>1</sup> These authors offer an intriguing set of propositions about the relative contract design capabilities of legal and technical players across broad categories of contract terms. However, they do not discuss the direction of influence and end with a challenge for future researchers “to develop more systematic ways of coding contractual clauses as a precursor to empirical testing of [term-specific] hypotheses regarding contracting capabilities” (Argyres and Mayer, 2007: 1074). In this study, we seek to answer that call.

roles as a possible explanation for both how and why relational learning about contracting may accumulate differentially across the organization and have differential impacts on contracting terms.

Organizational positions are associated with certain roles that reflect expectations in regard to the positions' contributions to operational tasks and objectives (Merton, 1957). These roles have been defined as the "set of behaviors that others expect of individuals in a certain context" (Floyd & Lane, 2000; 157). Organizational roles, based on the formal structure in organizations, tend to be highly elaborate, relatively stable, and well defined, not only for the individual in the role but for others who have occasion to deal with personnel situated in these roles (March & Simon, 1958). Therefore, interactions between individuals are conditioned by mutual expectations related to their particular roles (March, 1994; Bechky, 2006). Given the size and complexity of many organizations, the stocks of knowledge, incentives, and organizing principles relevant to innovation are dispersed by giving workers particular tasks to accomplish in order to direct and limit their attention (Cyert & March, 1963; Ocasio, 1997). Different goals are assigned to specific groups or individuals based on professional affiliations and organizational structuring of responsibilities into roles (Dougherty, 1992). Organizational roles and their related goals influence hiring decisions and rewards as organizations seek to attract and motivate those with the requisite professional training (e.g., lawyer, biochemist). Thus, individuals in these roles are typically guided by professional norms but are further motivated by organizational incentives. Moreover, particular roles expose individuals to certain streams of communication and shield them from other streams of communication, profoundly affecting what they know, believe, emphasize, fear, and propose (Simon 1947). This knowledge and task specialization engenders differentiation that is expressed as variation in key assumptions, attitudes, and behaviors (Lawrence & Lorsch, 1967). Finally, organizational roles tell organizational members how to reason about problems and where to look for appropriate and legitimate information to evaluate premises (Simon, 1991). Based on these roles organizational members develop distinct cognitive understandings that influence what information they focus on as they complete their tasks as well as the conclusions they draw (Tyler & Steensma, 1998). Thus, organizational roles direct different members' attention and trigger different search rules that

result in different kinds of learning within an organization. Further, roles serve as repositories of knowledge and learning, constituting a key form of organizational memory (Walsh & Ungson, 1991).

The above literature review suggests organizational roles and their impact on the focus of attention are likely to affect relational learning during project specification and contract negotiation, which influences how contract structures evolve with experience. To explore this premise, we sought a study context that would allow us to identify different organizational roles and investigate how these roles influence relational learning and contract evolution. This led us to the sponsored research context, which involves both scientists and contract administrators as key players in the contracting process. In addition to many informal conversations, we conducted semi-structured interviews with university contract administrators and scientists, in order to enhance our understanding of the study context, build hypotheses, and enrich the interpretation of our results.<sup>2</sup> In the next section we detail our study context.

### **Study Context: University-Industry Sponsored Research Relationships**

In line with the growth of inter-firm alliances, firms are establishing an increasing number of sponsored research relationships with academic institutions (Hagedoorn, 2002; NSB, 2010). These partnerships with university academics assist firms in both exploiting their existing capabilities and exploring new opportunities (Cohen, Nelson & Walsh, 2002; Rosenkopf & Nerkar, 2001).<sup>3</sup> Sponsored research agreements exhibit important characteristics that are relatively common with other cross-boundary innovation-based agreements: a multi-point relationship and exchange hazards.<sup>4</sup>

***Multi-point relationship.*** Sponsored research agreements involve participants, as well as negotiations, at multiple points. When a company sponsors research at a university, there are negotiations between university and company scientists and between contract administrators –

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<sup>2</sup> We conducted semi-structured interviews with two university contract administrators and five scientists involved in multiple contracts from different departments (immunology, neurology, pathology, radiology, and oncology).

<sup>3</sup> The number and value of sponsored research contracts has been growing for much of the past 25 years (Bercovitz & Feldman, 2007). Between 1980 and 1998, industrial support for university research increased from 4% of academic research spending to 7.4% and has remained above the 6% level since (NSB, 2010).

<sup>4</sup> The gross licensing revenue received by U.S. universities, hospitals and research institutes from industry has grown to over \$2.59 billion, and with this growth in interactions (both licensing and sponsored research) has come an increase in the number of lawsuits between universities and their corporate partners over royalties and other IP-related disputes (Walker, 2014-Wall Street Journal, Monday, January 6, 2014 B1).

technology-transfer personnel, corporate managers and lawyers. Initial discussions typically occur between scientists – the academic investigator (known as the principal investigator, PI) and the company scientist. Scientists we interviewed confirmed that either the company or university scientists make the first contact with their counterpart to probe the applicability of the other’s scientific expertise and the viability of establishing a research relationship as the scientists have the tacit knowledge required to ascertain the potential of the proposed relationship (Hicks, 1995; Zucker, Darby, & Armstrong, 2002). Scientists then jointly develop the scientific statement of work, which describes what is expected of the two parties in order to accomplish the scientific and technical ends proposed. The core elements of the project, including specification of research responsibilities and contributions of the exchange parties as well as preliminary monitoring and intellectual property terms, are drafted at this juncture. Only after the technical details and budget are established do the scientists contact contract administrators to assist in finalizing the contract. As one university scientist interviewed noted, “They [administrators] would not do a lot until we worked out what we were going to do, the agreement and the budget. Then the contract administrators got involved.” The university contract administrators then interact with corporate contract administrators to finalize the contract with an eye to broader organizational and administrative interests. Here, the umbrella agreements codifying overall guidelines and contract terms that have evolved in both the company and the university are adjusted to address specific project goals put forth by the scientists and then negotiated across all parties (Gerwin & Ferris, 2004). At this point, contracting becomes an iterative process involving both scientists and contract administrators. The end result is typically a formal contract signed by multiple personnel, e.g., the PI and the university contract administrator and the company contract administrator.<sup>5</sup> The statement of work and budget drafted by the scientists is attached and considered part of the formal legal agreement.

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<sup>5</sup> In practice individuals charged with contract management responsibilities come from a variety of educational and professional backgrounds (e.g., managers, engineers, scientists, lawyers). For example, the primary university contract administrator in our study has a PhD in biochemistry, and two decades of experience in the sponsored research office of the university.

Sponsored research agreements are often recurrent, enabling the exchange parties to build relationships and experiment with safeguards calibrated to varying degrees of risk. Relationships develop between university scientists and the company on the technical level, as it is relatively common for an academic scientist to conduct multiple research projects for a particular company over time. As one scientist interviewed said, “You get to know each other. They get to know what your strengths are and you get to know what the company’s strengths are. It becomes a friendship but also a scientific collaboration that makes these successful.” Similarly, companies may have repeated involvement with a particular university as they conduct numerous projects with multiple investigators, leading to relational learning between the university and company. Given that individual company scientists are dispersed among a variety of operational divisions, it is common for these scientists to tap different contract administrators across the firm to handle negotiations. The multi-point character of sponsored research agreements along with the commonality of repeated interaction provides an opportunity to explore how prior experience between multiple organizational roles are related to contract design and evolution.

*Exchange hazards.* Consistent with other innovation based inter-organizational relationships, sponsored research agreements are subject to exchange hazards and, thus, require contractual safeguards. Sponsored research agreements, by their nature, involve discovery and the generation of knowledge and thus may face appropriability hazards, which may be further increased when the company contributes proprietary materials to the project (Oxley, 1997). As a university scientist describes, “Most [firms] are pretty concerned about their materials, this is early on and they do not want their materials torpedoed.” Given these concerns about value appropriation, terms regarding intellectual property protection and allocation are often at the center of contract negotiations. Measurement-related hazards may be an issue as academic scientists follow different rules of “timeliness” and record keeping than is common in the private sector (Thursby & Thursby, 2000).<sup>6</sup> As such, monitoring and reporting is often another focal

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<sup>6</sup> It’s not that academic scientists do not maintain records, but rather that different methods and systems are likely to have been adopted in the two different kinds of organizations. Dr. Richard Insel, VP of Research at the JDRCF, said “Public-private operational differences can contribute to misunderstandings, delays, and duplication of effort. The worlds of academia and industry are different in several key ways.” (Hanson, Nadig, and Altevogt, 2009:30)

point of discussion when agreements are drafted. Finally, exchange hazards associated with technological uncertainty can be expected to affect contract structure (Carter & Hodgson, 2006). The potential for numerous exchange hazards within the sponsored research relationship provides an excellent context in which to examine roles, inter-organizational relationships, and the evolution of contract structure, while controlling for transaction attributes. While contracts play enforcement, definitional, and contingency planning functions in inter-organizational relationships (Macaulay, 1963), we concentrate our discussion of contract detail on their enforcement function as this is the area of traditional concern in innovation-based agreements where new knowledge may be generated.

### **Hypothesis Development**

*Scientists and repeated ties.* Scientists, responsible for knowledge creation, are hired into particular units based on their disciplinary focus, technical knowledge, and research competence. Given their organizational role, they generally focus their attention on technology acquisition and development (Daft, 1978; Reitzig & Puranam, 2009). More specifically, “scientists” are charged with generating and sourcing scientific knowledge, translating this knowledge into commercial potential, and/or contributing to their community of knowledge (Roach & Sauermann, 2010). As detailed previously, sponsored research agreements are typically initiated by scientists, who in their role contact their counterpart because of the specialized type of research they conduct and their preeminence in their field. One scientist related the origins of a company research relationship as follows,

“I wrote a review on this in 1987, with just a little pilot data, and the next year this company contacted me and said you get it. You are thinking out of the box because no one else is really thinking of doing this so that’s why we want to work with you. We don’t want you to just collect blood we want you to think this through and help us to find a clinical context and exactly how it would be used. Help us find what the test characteristics would need to be to be useful clinically. We have great scientists and engineers but what we need is to do a collaboration with someone that understands the clinical science behind it...”

Because of the scientists’ distinct knowledge sets, there is often continuity in future contracts as subsequent projects are based in the same knowledge domain and, thus, tend to involve the same people, units, and laboratories.

Scientists, within their organizational role, have a variety of incentives. University scientists are motivated by the need for continued funding for their research, the freedom to use IP developed in future research projects, publications, scientific recognition of their peers, and the intrinsic desire to advance science (Stern, 2004; Roach & Sauermann, 2010). With respect to the first point, one scientist stated,

“The main reason [I do sponsored research] is I have a fairly large lab with people that want work to do. Federal contracts and grants don’t cover it all so you have to diversify your source of funding to be sure your people are covered. That is the financial reason but I don’t take contracts that are not interesting to me so that is the other part. It has to be scientifically interesting. . . My motivation is to get students trained. I’m a teacher, to me that is my mission, that is why I am here and that is why I need money.”

University scientists have an additional monetary incentive as they share royalties resulting from the licensing of their research. At the university studied the royalty is split 1/3 to the scientist, 1/3 to their department, and 1/3 to the university. Given this, scientists are very interested in IP rights. Beyond monetary concerns, university scientists tell us they are very concerned with the specification of IP rights because they want to ensure they have freedom to operate. More specifically, they want the freedom to use past findings in future research programs without infringing on the IP rights licensed to their partners and to be sure that they will not be restricted from engaging in future sponsored research projects with other companies. A contract administrator summed up the major interests of scientists as follows: “What is really important are the rights to use the data and how constrained are you in publishing.” Thus, based on their knowledge set, scientists are hired into an organizational role. This role and its related goals determine the attention rules and search rules which, in concert with incentives, direct behavior.<sup>7</sup>

The scientists’ role as knowledge creators for their organizations motivates them to search for, and be open to, inter-organizational relationships. The formation of inter-organizational research agreements requires the scientists to negotiate a statement of work (what the scientists will do), a preliminary budget (amount for particular activities), and an initial allocation of IP rights. Once the agreement is signed the university scientist conducts the research as outlined and provides the agreed upon reports. Company scientists may run parallel experiments, have onsite involvement, and share

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<sup>7</sup> Research has shown that, even controlling for incentives, attention influence behavior. Kaplan (2008) found that cognitive attention explained technical investments over and above incentives in her study of communication firms.

information. When university scientists were asked whether they felt that requests for reports were onerous, they said no. In fact they reported that they encouraged reporting requirements, at least in the initial agreement, to help set expectations. Additionally, scientists saw collaborative benefits. One scientist said “I thought of it [reports] as information sharing, and they would give us feedback....It felt like a partnership, a cooperation”. Moreover, our interviewees confirm that company scientists, as well as university scientists, seek to publish their findings (Henderson & Cockburn, 1994).

Given increasing technical specialization, scientists involved in cross-boundary innovation projects in a particular domain often include a consistent set of experts who are then called upon to implement subsequent projects (Jones, 2009; Zucker et al., 2002). Through repeated interactions, these scientists have the opportunity to gain a deep understanding of each other’s scientific skills and character (reliability, timeliness), enabling them to reduce both competence and behavioral uncertainty (Lazzarini, et al., 2008). Further, innovation activities often involve the generation and transfer of both codified and tacit knowledge (Arora & Gambardella, 1994). While publications by scientists serve as signals that they have the tacit knowledge necessary to participate in the exchange of scientific knowledge (Hicks, 1995), publications and written reports alone are not adequate to relay the tacit knowledge necessary for the complete transfer of scientific insights.<sup>8</sup> Effective transfer of tacit knowledge between exchange partners often requires intimate personal interaction and a willingness to admit limits to one’s own knowledge (Nonaka, 1994). Thus, while professional training and norms in science set the stage for transfer of some aspects of technology, trust and confidence in one’s partner may be required to successfully transfer tacit forms of technology (Faems et al., 2008). Moreover, as scientists experience repeated contacts which lower behavioral uncertainty about their partner, these contacts also allow scientists to better evaluate the technical uncertainty associated with the program of research. As the parties interact first in developing the statement of work, and then in the actual project, they are better

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<sup>8</sup> There is evidence that even advances that spawn publications and that are highly valued for their commercial potential can rarely be transferred totally via codified documentation (Zucker, et al., 2002). Jensen & Thursby (2001), in their study of university technology licensing, report that over 75% of the inventions licensed were no more than a proof of concept. For 71 % of the inventions licensed, respondents claimed that successful commercialization required cooperation by the inventor to transfer tacit knowledge and develop the technology.

able to judge the scientific expertise of their partner, which can add certainty about competence levels (Lazzarini, et al, 2008; Zucker, et al, 2002). In the words of one university scientist,

You either have a trusting relationship with a company that's personal and they will work with you to accomplish your needs and you'll work with them with mutual trust or you are kinda a mercenary type ... for me that longstanding relationship and that trust is what it's all about. It led to 8 years and over a million dollars. When the company was bought out and some of them started another company, now I am working with them because it is personal. They are smart, they are honest, they are investing a lot of their money in bio-development, they have a vision and a long time horizon. They were not scared of challenges or focused on low hanging fruit. They wanted to make a difference so they were just people that I felt comfortable working with."

Consistent with their role, the interactions between scientists needed to create scientific advances will lead to a greater understanding of the operational requirements for knowledge exchange. In turn, this may result in the development of relationship-specific routines to guide the interactions between scientists across organizations (Dyer & Singh, 1998; Zollo, et.al., 2002). Our interviewees indicated that in the course of working together partners developed practices that guided their interactions:

I think companies need to understand how we operate.... One of the key things is that we are absolutely honest in the way we do our work. We are very transparent and do not try to hide things... early on it helps to meet in person. They came down here once, I went up there. Early on you need the face-to-face.... The relationship is with the person not the company.

For the [X] project the project manager was very involved, he was talking to [us] every week... It is more than monitoring,. . . its priority setting and figuring out which experiments we are going to do first. . . Coordination is important, and integration.

Scientists will be aware of technical problems, have the expertise necessary to solve these problems, and adopt routines to address these operational issues (Mayer & Argyres, 2004). Given scientists' professional norms, we can expect the operational routines that evolve will be loosely coupled with evolving administrative routines (Daft, 1978; Faems et al., 2008). Moreover, the development of relationship-specific operational routines may reduce coordination and communication challenges. Scientists with sufficient partner-specific experience may more readily recognize the technical potential of the research, communicate tacit knowledge, and judge the veracity of data generated by their partners.

Guided by their role-based focus of attention, knowledge sets, and incentives, scientists may, over time, adjust their contracting behavior given experience with a partner. When scientists have not

previously contracted with an organization, they will be more concerned about specifying the contract as completely as possible. They want to know what they will get (e.g., money and proprietary technology), what they must do (e.g., experimental specifications and reports), and what rights they have (i.e., to the IP they bring to, and the IP that is generated from, the funded research) in order to protect themselves from misunderstandings or opportunistic behavior. However, the scientists' time is a precious commodity and their time is the major expense associated with this often complex negotiation process. Thus, once scientists have developed confidence in the expertise and behavior of their counterparts, they can be expected to be less concerned about potential misunderstandings and opportunism and more concerned with getting on with their research. In such instances, they may choose to forgo the expense of negotiating detailed monitoring and IP rights and, because over-specification or excessive formalization can interfere with relationship development, may even remove terms from the agreement (Malhotra & Murnighan, 2002). As behavioral and technical uncertainty is reduced and/or operating routines are developed, authority and control systems can be more loosely specified in the contract, and production related matters may be left relatively open-ended (Barney & Hansen, 1994; Reuer & Arino, 2007). This reasoning is not meant to suggest that scientists do not also learn to contract (Argyres & Mayer, 2007), but simply that because, in their organizational role, their attention is focused on knowledge creation oriented tasks (Moran, 2005; Ocasio, 1997), uncertainty reduction, and operational routine-related relational learning. Thus, as university scientists gain experience contracting with a company, enforcement terms of contracts can be expected to be less detailed. As such, we hypothesize:

*Hypothesis 1: As university scientists gain experience contracting with a company, monitoring and intellectual property terms will be less explicitly specified.*

**Contract Administrators and repeated ties.** Contract administrators, due to their organizational role, focus their attention on governance problems of inter-organizational relationships, learn contracting practices, and develop administrative routines to address these problems. In our study context “contract administrators” serve as the organization’s representative 1) responsible for protecting the interests of the organization and its personnel (knowledge protection), 2) managing research agreements that occur

across public/private interfaces in accordance with state and federal guidelines, and 3) serving in an alliance management function as it pertains to contractual details (Kales et al., 2002).

Contract administrators are not necessarily lawyers, although lawyers may advise the contract administrators (Weber et al., 2011). For example, the three university contract administrators employed at the time of the study held PhDs in biochemistry, immunology, and chemistry - none had a law degree. As described during interviews, they were hired into their positions based on a broad knowledge set that includes technical/scientific knowledge – which enables them to communicate with scientific specialists, some knowledge of contract design, and strong inter-personal and negotiation skills. Through experience and access to prior contracts executed by the university, which serve as an important repository of contracting knowledge (Mayer & Argyres, 2004), as well as contact with university legal staff, they gain additional contracting skills. The potential for learning is heightened by the sheer volume of agreements handled. In our study, university contract administrators negotiated 119 contracts over a ten-year period with a single company, and, in 2004 alone, three university contract administrators finalized 126 agreements with 66 companies. One contract administrator, in discussing his experience and how he learned to contract, described his approach as follows:

"I have what I call cheat sheets for every type of agreement that I do, and they basically will say what terms I am going for and why, and I will add to it as new situations come along, or new regulations come along.... The office has learned as they went along."

Contract administrators build contract design expertise by keeping current on legal developments and proactively contacting legal counsel to be sure their contracts are enforceable and strongly supportive of their organizations' interests. Finally, when necessary, contract administrators are engaged in dispute resolution and litigation preparation. Thus, the contract administrators are hired based on their knowledge and skill sets, but their attention on contract design and knowledge protection and their learning is a direct result of the role they have been assigned in the organization.

Contract administrators, within their organizational role, have a variety of incentives that motivate their behaviors. They receive a salary, are evaluated for bonuses and raises on their success in efficient (do the deals get done) and effective (are the deals done right) contract design, and are able to

gain a reputation for successful contracting that can lead to additional financial rewards. Furthermore, our contract administrators are intrinsically motivated to assist scientists in accessing the funds and partners necessary to move their research forward, while also protecting the individuals and organizations they represent. One of the contract administrators said, “A large part of our role is to serve the faculty. It is important to faculty that we are trying to serve them, but we see our roles as protecting the institution, which itself in theory serves the faculty”. In their role as contract administrators, they assist scientists seeking to establish sponsored research relationships and manage the negotiation process once they are asked to get involved. They interface with multiple parties to reach a consensus on acceptable terms. For example, one contract administrator described the typical process as follows:

The project is usually initiated by the scientists. Sometimes it's the scientist of the company, sometimes it is the company representative, or our own scientist... [We] review the agreement or pull out a template for the project. Have discussions with the faculty or their business manager about budgets and scope of work. All of that goes parallel with negotiating the agreement terms with the company. We might contact them [the company] or if someone sends us an agreement we would just respond to whoever sent the agreement. [It] may be a contracts office in the company, it may be the scientist in the company, we may deal directly with corporate attorneys, it really varies. Some companies have conference calls with 5 people on the call, some will handle it primarily by mail. The median [exchange length] is about 30 days for negotiation time...The outliers are 6 months to a year.

Thus, in sponsored research relationships, contract administrators, because of their role, develop contracting practices that prioritize knowledge protection and alliance management terms and develop the relationship-specific administrative routines required to efficiently and effectively draft such terms (Zollo, et.al., 2002). When asked what was most contentious and where he concentrates his attention a contract administrator responded, “Intellectual property rights...take a lot of time...There will be reporting requirements, the terms and final report, as well as who owns the reports, both the physical final report and who owns the data contained in the reports. . .and how does that affect IP rights”. They are not involved in designing the operational routines or the actual flow of scientific knowledge (Ferlie, et al., 2005; Simon, 1947). In their role, these experts are detail oriented in regards to legally formalized contracts (Chreim et al., 2007). As the experts with regard to legal agreements, contract administrators bring their experiences with prior contractual problems to the task and use the lessons learned from these

experiences to avoid hazards resulting from serious contract incompleteness (Cyert & March, 1963). In addition, these experts stay abreast of developments in knowledge protection and risk management (Daft, 1978). Minimization of risk through governance is often given priority by contract administrators, at times at the expense of facilitating the operational objectives of the innovation-based relationship (Bagely & Dauchy, 2008). As one scientist complained “Once you see eye to eye and have a common vision [with the firm] that’s easy, the hard part was working through the layers of the university’s bureaucracy. Working with thoughtful people is easy. Going through the university is hard”.

In repeated contracting, as the result of developed contracting practices and administrative routines, contract administrators are likely to increase rather than decrease the level of contract specification of monitoring and intellectual property terms for two primary reasons. First, through experience contracting with a given exchange partner, contract administrators learn what types of monitoring mechanisms and intellectual property terms are needed as well as which are effective. Since problems encountered in the past may be problems in the future, contract administrators prefer to start the negotiation process with the last partner-specific contract and then elaborate with an eye to current conditions. A university contract administrator illustrates this learning process:

“Our template typically serves as a standard for our people. We will go back and see what we did last time and typically will be responding with a red line version of their contract and will tell them this is what the company agreed to last time. Some companies are very good at starting out with what we agreed to last time.”

Since these agreements are intended to ensure that knowledge is transferred between partners, unauthorized diffusion to external parties is limited, and bi-lateral hold-up around IP licensing is minimized, repeated contracting should result in more explicit specification of monitoring and IP terms.

Second, contract administrators have fewer opportunities to resolve behavioral and technical uncertainty and thus are likely to retain contractual safeguards specified in the initial interactions in later contracts. While the importance of scientific expertise in a specific domain limits interchangeability of scientists, expertise of knowledge protection is not project specific allowing contracting to be conducted by different contract administrators. As such, multiple individuals may be brought in to negotiate

administrative contract solutions over time, especially in large companies.<sup>9</sup> The introduction of new participants will slow the development of the foundation required to ascertain behavioral uncertainty in any specific university-company sponsored research agreement or understand the social norms (e.g., trust) that have been established that might substitute for formal governance.<sup>10</sup> Thus, when repeated research agreements occur between universities and companies, we submit that, for contract administrators, these repeated ties are more representative of an accumulation of knowledge related to the contract design and relationship-specific administrative routines rather than uncertainty reduction and operational routine forms of relational learning. Thus, we expect:

*Hypothesis 2: As university and company contract administrators gain experience contracting across a university-company dyad, monitoring and intellectual property term content will be more explicitly specified.*

## METHODS

### Data

To test our hypotheses, we collected non-clinical Industry Sponsored Research Agreements (SRA) from a private research university with a well-known medical school. The university provided access to the close to 1000 non-clinical research agreements signed 1994-2005. The dataset used is based on a sample of 136 of these agreements pulled via a stratified random sample selection process. Specifically, contracts were separated into categories based on the number of interactions between a principal investigator-company pair, because some PI-company pairs have only one agreement while others have signed multiple contracts over time. Next, agreement sets were randomly selected from each category (2-, 3-, 4- and 5-contracts) in proportion to their distribution across the full population of contract sets.<sup>11</sup> As there were few PI-company pairs with more than 5 repeated contracts these larger sets are not represented in the sample. Our repeated interactions, ranging from 2-5 agreements, took

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<sup>9</sup> When rating how likely they were to deal with a new individual when negotiating a new contract at a company they had dealt with before, university contract administrators gave a rating of 3.5 (7 pt. scale from never to always).

<sup>10</sup> Argyres & Mayer make a similar point maintaining that, "Lawyers are less likely to be an integral part of the relationships that develop at the operating level and, thus, are less likely to have the knowledge possessed by the managers and engineers about what is likely to occur during the execution of the project" (2007: 1064-1065).

<sup>11</sup> The distribution of sets (PI-Company pairs) in the population of repeated interactions was: 2 related contracts–65.8%, 3 related contracts–16.3%, 4 related contracts–11.4%, 5 or more related contracts–6.5%.

place over a period of between 1-7 years from the start of the first agreement to the end of the last agreement. The average time-span for these repeated interactions was 3.5 years with a median of 3 years. Given our interest in repeated interactions, we chose to oversample from contract sets in comparison to single, one-time, PI-Company pairs. Whereas one-time interactions comprised approximately 2/3 of the PI-Company agreements in the total population, they account for slightly less than 1/3 in our sample.<sup>12</sup> The contracts, ranging from 7 to 25 pages, were content analyzed. We coded each contract for terms related to the constructs of interest, keeping a running list of all elements mentioned and letting the final categories emerge from the actual contract content. Thus, we were able to capture not only the provisions included but also the terms embedded in the detailed text.

### **Dependent Variables**

Four dependent variables, which emerged from the content analysis of the contracts, are used in this study. Two variables capture monitoring term content and two capture intellectual property term content. We chose to look specifically at the monitoring and IP terms for several reasons. First, technology transfer personnel highlighted these two categories of terms as ones they paid particular attention to in the negotiation process and in our interviews the PIs confirmed the importance of these categories. Similarly, corporate sponsors of university research also identify monitoring and IP issues as central concerns (Bercovitz & Feldman, 2007; Somers, 2003). Formal monitoring and IP safeguards are used to guarantee that scientists transfer intended knowledge, that the sponsor is the priority recipient of knowledge generated and that opportunism around IP appropriability is minimized. Second, initial reviews of the contracts showed that, as compared to other categories of terms, the monitoring and IP provisions varied significantly across contracts. Third, these categories fall within the two underlying dimensions of contractual complexity (based on their coordination and enforcement functions) specified, and which recent research has held to be differentially influenced by prior ties (Reuer & Arino, 2007).

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<sup>12</sup> There are 72 unique principal investigators, 47 unique companies, and 84 unique PI-Co pairs in our sample. Ten PIs are involved with more than one company. Of the 47 companies in the dataset, 13 have agreements across multiple PIs. While slightly smaller in dollar amount than the population, the sample is representative in terms of the home departments of the principal investigators.

These variables represent primarily the enforcement role of contracting, as our content analysis of the contracts found little variance in provisions related to definitional and contingency planning roles.

The first monitoring variable, ACCESS, quantifies the level of company access specified in the contract. Across the sample contracts, six specific content terms relating to sponsor access were found. These include statements stipulating that: (1) the sponsor be allowed to visit the research site; (2) the sponsor be given access to data generated through the research project; (3) review meetings between the principal investigator and company scientists be scheduled; (4) research results be jointly evaluated and know-how developed be shared; (5) a company representative be named; and (6) a joint scientific advisory board be formed. The measure ACCESS is simply the sum of the number of the above items included in the contract.<sup>13</sup> The value of ACCESS ranged from 0 to 5 (mean of 1.43).

The second monitoring variable codes reporting requirements (REPORT) detailed in the contract. Reporting facilitates monitoring in two respects. It provides incentives for participants to perform to expectations and it provides a metric that can be used to reduce information asymmetry making it easier to monitor. There is great variation in reporting terms. Contracts varied by whether it was explicitly stated that (1) the PI needed to maintain records documenting project activities; (2) a final report was required; (3) interim progress reports were called for (4) in a specific number with dates for report delivery. The fifth clause outlined content elements to be included in the reports. The variable REPORT, calculated as the sum of the above terms present, ranged from 0 to 5, with a mean of 2.17.

The first intellectual property dependent variable, ALLOCATE, measures the attention paid in the contract to the specification and allocation of IP rights for inventions resulting from the sponsored research. In general, ownership of inventions made by the PI remains with the University, with the sponsor being given an option to negotiate a license.<sup>14</sup> Where contracts differ is in:

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<sup>13</sup> This summation approach is limited in that it gives each clause equal weight. This is a reasonable default given no grounded reasons for assigning different weights to each clause. Robustness tests using different weightings were conducted and are discussed in the results section.

<sup>14</sup> A typical boilerplate term reads: To the extent that the UNIVERSITY has title to any new Inventions resulting from the Research solely or jointly with SPONSOR, Sponsor is hereby granted, without option fee other than consideration of the Research sponsored herein and the reimbursement to UNIVERSITY for patent expenses

- (1) the expansiveness of the option offered – is the license to be negotiated worldwide, exclusive, perpetual, and does it give the sponsor sub-license rights?;
- (2) the length of time allowed for the sponsor to exercise and negotiate a license. A basic option clause provides for a 3 month exercise period and a 3 month negotiation period.
- (3) the licensing framework laid-out – whether the contract sets parameters for acceptable license terms, details a process for license term negotiations and/or specifies that the sponsor has a first right of refusal to the license the invention on terms negotiated with any third party; and
- (4) the number of items that are included to insure that the sponsor has an unobstructed right to the invention – a warranty clause confirming that no third-party will have rights to intellectual property developed, restrictions on the PI's right to engage in other sponsored research projects, specification that the sponsor owns the data generated through the sponsored research, and/or the delineation of a subset of inventions for which, ex ante, the sponsor is granted ownership rights.

The ALLOCATE measure was constructed by summing the scores from each of the four categories. The scores for categories (1), (3), and (4) simply count the presence of each element in the contract, whereas the score for category (2) is determined by the total exercise/negotiation period granted with one point given per 3-month interval.<sup>15</sup> ALLOCATE ranges from 0 to 11, with an average of 5.57.

The second intellectual property variable, PUBLICATION, is a measure of the publication constraints included in the agreement. The publication and dissemination of research findings is a core value in the academic arena. Both personal and societal advancement are linked to this traditional open science norm. Industry sponsors, in contrast, often desire to limit and/or delay the release of new knowledge in order to use such private knowledge to secure a competitively advantageous position. Almost all sponsored research agreements contain a publication clause that sets terms to balance these competing interests. Standard publication clauses provide the Sponsor with a short window of confidentiality to allow for patent application filings before public dissemination of research results.

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incurred prior to or during the option period, an option to acquire a royalty-bearing license to UNIVERSITY'S right in the Invention.

<sup>15</sup> There is significant variation in the exercise/negotiation periods (see Table 1). The initial coding scheme, which weighs extended negotiation periods more heavily, captures this variation. However, we recognize that timing considerations may be different in character than the other allocation contract elements. As such, we conduct robustness checks in which the timing elements are dropped entirely or given a simple 1/0 coding for the specification of any negotiation period. Our findings, detailed later, are robust to these alternative coding schemes.

Publication clause content varies in four respects: (1) the allowable period for review and delay to allow for patent submission, (2) the right for the sponsor to comment on the publication and that such comments will be “considered in good faith” by the authors, (3) the additional right to delay publication given concerns about content, and (4) the right to require specific revisions to articles before they are released for publication. Specified review/delay periods are coded as 1 for periods up to 90 days, 2 for periods between 91-120 days, 3 for periods between 121-150 days, and 4 for periods greater than 150 days to reflect the variation of these periods.<sup>16</sup> The score is increased by one for each of the remaining three variations – right to comment; right to delay given content concerns; and right to require revisions. The value of the PUBLICATION variable ranged from 1-7 with an average of 1.68. Table 1 summarizes the frequency of each element of the four contract measures found in the 136 contracts in the dataset.

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 Insert Table 1 about here  
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### **Independent Variables**

Two different relationship history variables are used to test our hypotheses. The first variable, PI-CO HISTORY used to test H1, is a count of the number of sponsored research agreements that the individual principal investigator has conducted with the same company prior to the current contract. The number of previous contracts between an individual PI and a specific company range from 0 to 4.<sup>17</sup> The second variable, UNIV-CO HISTORY used to test H2, measures the contracting experience between the University-Company dyad via the log of the number of previous sponsored research interactions between these two parties.<sup>18</sup> To insure that the Univ-CO History variable captures past inter-organizational

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<sup>16</sup> As with ALLOCATION, alternative PUBLICATION coding schemes that removed or provided equal weightings for the timing provisions were explored and are reported in the results section.

<sup>17</sup> We also coded length of relationship as an alternative measure of PI-Co history. The characteristics of our data weaken the viability of this alternative. First, while we have duration data for the execution period of the agreements we do not have complete information about time spent in negotiation and development. The average agreement is relatively short (about 15 months) while the time spent developing the statement of work and negotiating the agreement, can be significant. As such, there are issues in using contract duration alone as a proxy for the relationship. Results were consistent, with a slight loss of significance, using the time-based variable.

<sup>18</sup> The UNIV-CO History variable is a measure of inter-organizational relationships not a measure of a relationship between two specific individuals representing the two organizations. Unlike scientists that hold specialized scientific knowledge in a research domain, different contract administrators having deep generalizable contracting knowledge may be brought in to negotiate administrative contract solutions, especially in large companies.

relationships rather than concurrent activities, we count only those agreements that were signed more than 12 months prior to the focal agreement. This variable is calculated using the full population of contracts signed by the university between 1994 and 2005. A particular company may engage in sponsored research agreements with a number of different investigators at the same university. In our sample the most active company sponsored 119 research projects with a total of 70 different PIs.

### **Control Variables**

Our first three control variables operationalize transaction-level attributes of the research project that may influence contract structure. Sponsored research transactions differ in the contributions of the partners. It is not uncommon for the sponsor to provide proprietary inputs to the investigator. For example, the sponsor may supply sophisticated laboratory testing equipment or diagnostic devices for either equipment validation or investigative studies. Similarly, sponsors may provide materials – transgenic mice or experimental drugs – to allow the investigator to explore new applications or test efficacy. Contribution of such proprietary assets may give rise to moral hazard (in the maintenance of the equipment) and appropriability hazards (in the opportunistic use of specialized materials) and thus are expected to require increased levels of safeguards. We use two dummy variables *EQUIPMENT* and *MATERIAL*, coded as 1 if the sponsor provides such an item, 0 otherwise, as controls for such concerns.

We also include a binary variable, *BASIC*, as an indicator of the technical uncertainty associated with the sponsored research project. Technical uncertainty makes it difficult to contract ex ante for contingencies that may occur ex post and thus may be associated with the adoption of less explicit contract terms (Crocker & Reynolds, 1993; Williamson, 1985). Scientific research always involves some degree of uncertainty (Mowery & Rosenberg, 1989). The uncertainty of projects focused on basic, fundamental, scientific advancement, however, is expected to be greater than the uncertainty of projects in applied fields with developmental goals. We use the terminal degree of the PI – PhD or MD – as a proxy for project type. Conversations with technology transfer officers suggest faculty with PhD degrees are more likely to engage in basic research than faculty members with the more applied MD.

We include several other project-related or organization-related control variables. First, we add DURATION, to control for the specified period of performance (months) of the project. More attention may be given to the negotiation and design of contracts that will be in force longer. Second, we enter BUDGET, measuring the total monetary value of the sponsored research project. We use the natural log of this value in order to constrain the effect of outliers. Third, we include a measure of company age as start-ups may behave differently than well-established firms. The variable AGE takes the value of 0 if the firm was started prior to 1980, 1 if the firm was formed 1980-1990, and 2 if the firm begun operations after 1990. Fourth, we use the log of the aggregated number of contracts entered into prior to the focal contract by the University as a proxy for the University's cumulative experience drafting sponsored research agreements, UEXPERIENCE. In the period of interest, the university's annual involvement with sponsored research projects increased from less than 60 in 1994 to more than 200 in 2005. This increase in activity allowed for growth in the stock of knowledge regarding contract design.

We also control for PI-related differences. First, we include CONTRACTING EXPERTISE to control for the PI's experience in structuring, negotiating and conducting sponsored research agreements. This variable is measured as the number of non-clinical sponsored research agreements (SRAs) across multiple companies this faculty member has participated in prior to the date of the focal SRA. Experience levels vary considerably, ranging from 0 to 14 previous engagements. Second, we control for the TECHNICAL EXPERTISE of the principal investigator using a citation rate measure. This measure is constructed as total citations within the 5-year post-publication period for the papers published by the PI in the 5 years prior to the commencement of the focal SRA. PI expertise could translate into increased bargaining power enabling the PI to shape the structure of the agreement. We also control for departmental context of the principal investigator by coding the PI's home department in terms of the percentage of faculty members in that department who have PhDs. Previous research has shown that the behavior of academic scientists is often influenced by their localized social environment (Bercovitz & Feldman, 2008). Finally, we include time period dummies – Time1=1 for agreements

initiated from 1994-1997; Time2=1 for agreements initiated from 1998-2001; Time3=1 for agreements initiated from 2002-2005 (the omitted category) – to control for period effects.

### **Methodology**

We test the hypotheses using a seemingly unrelated estimation procedure (Suest). We use an ordered logit specification to fit the original models followed by the “suest” procedure. Suest can be used for estimating multiple ordinal dependent variables with common sets of independent variables. This method allows for comparison across models and improves the efficiency of parameter estimation when the error terms for multiple regression equations are correlated (Pindyck & Rubinfeld, 1991). If the dependent variables are produced by a common set of factors, as we believe to be the case in the selection of contract terms, and these factors are imperfectly captured by the regression equation (either due to measurement error or omitted variables) it is likely that the residuals from separate regression equations would be correlated. Thus, a seemingly unrelated estimation approach is warranted.

## **RESULTS**

Descriptive statistics and correlations are presented in Table 2. Table 3 reports the results of the seemingly unrelated estimation with errors clustered by company.<sup>19</sup> Consider first the monitoring equations. H1 and H2 are supported in both the access and reporting equations. The coefficient on PI-Co History is negative and significant ( $p < 0.05$  for ACCESS and REPORT). When the PI and the company have previously engaged in sponsored research projects, the access and reporting terms detailed in the contract are less onerous, consistent with H1. In line with expectations regarding the role-based focus of scientists’ attention on knowledge creation, this finding is indicative of an accumulation of relational learning associated with uncertainty reduction or operational routine development. To get a sense of the substantive impact of these effects we conduct post-estimation tests as suggested by Hoetker (2007). We evaluate the sensitivity of the two dependent variables (ACCESS and REPORT) to a one-standard deviation change around the mean of the PI-Co History variable. With this one-standard

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<sup>19</sup>Models in which each of the key independent variables were entered independently were also estimated. Results were consistent with the full model.

deviation increase in PI-Co History, the change in the probability of having an ACCESS score of either 2 or 1 (scores that bracket the mean of the ACCESS variable) decreases by 35% and 5% respectively. Similarly, with a one-standard deviation increase in PI-Co History, the change in the probability of having a REPORT score of either 3 or 2 (scores that bracket the mean of the REPORT variable) decreases by 25% and 14% respectively. These changes are non-trivial.

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Insert Tables 2 and 3 about here  
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To further investigate the practical impact of the deletions, we went back to the raw data to document which REPORT and ACCESS terms were removed over time. For PI-Company pairs having repeated interactions, we saw the removal of Reporting clauses in approximately 44% of the contract sets. The REPORT term dropped most often was the requirement for the “PI to maintain records documenting project activities”. The second most frequently eliminated term was “the specification of content elements to be included in the reports”. Thus, the changes in REPORT terms observed are consequential. The fact that these particular terms were not included in the later contracts of a PI-Company relationship is consistent with the development of operational routines as dyad experience increases. Similarly, the observed changes in ACCESS terms were noteworthy. For PI-Company pairs having repeated interactions, Access clauses were removed in approximately 40% of the contract sets. Two terms showed a significant amount of action: Both clauses naming a company representative and clauses detailing sponsor access to the research site were left out in later contracts. As with REPORT, the observed patterns of ACCESS term removal are non-trivial as they delineate roles and points of contact for monitoring and information exchange.

Conversely, the coefficient on Univ-Co History is positive and significant for access ( $p < 0.05$ ) and reporting ( $p < 0.10$ ). In line with H2, we find that the greater the company’s experience in contracting with the university, the more thoroughly access and reporting terms are detailed in subsequent sponsored research agreements. It appears that for administrative roles, repeated agreements result in greater awareness of potential problems that manifests in more explicit specification of contract

terms, suggesting the development of administrative routines and an enhanced toolbox of governance solutions. As above, we investigate the substantive impact of these effects. We find that a one standard deviation increase around the mean of Univ-Co History considerably increases the probability of having ACCESS and REPORT scores that are above the sample mean. For ACCESS, such a change increases the probability of a score of 2 or 3 by 32%, and 43%, respectively. For REPORT, such a change increases the probability of a score of 3 or 4 by 44% and 51%, respectively.

The results for the intellectual property (IP) right equations are summarized in the final two columns of Table 3. Consider where ALLOCATE is the IP dependent variable first. Our results provide consistent support for the role-based hypotheses, H1 and H2. As predicted in H1, previous sponsored research activity within a PI-company dyad is negatively and significantly ( $p < 0.01$ ) related to the level of IP contractual detail in the current agreement. When gained between scientists, experience with a partner may produce confidence in the technical competencies and character of the scientist and reduce the perceived need to draft explicit formal contracts. However, and as predicted in H2, the coefficient on UNIV-CO HISTORY is positive and significant ( $p < 0.01$ ). The greater the number of prior sponsored research agreements conducted between the university and a firm, the more explicit the IP allocation terms. In-line with the contract administrator role where attention is directed to knowledge protection, firms use the knowledge gained across university-company dyads to refine and expand IP allocation terms in subsequent agreements indicative of the development of administrative routines and governance solutions. Further, calculations show that a one-standard deviation change in either PI-Co History or Univ-Co History has a substantial impact on IP allocation scores. With a one-standard deviation increase in PI-Co History, the change in the probability of having an ALLOCATION score of either 6 or 5 (scores that bracket the mean of the ALLOCATION variable) decreases by 30% and 16% respectively. Similarly, with a one-standard deviation increase in Univ-Co History, the change in the probability of an ALLOCATION score of either 6 or 5 increases by 43% or 24%, respectively. In Table 3 we do not find support for our hypotheses when PUBLICATION is the dependent variable. Neither prior investigator-company cooperation nor organizational experience has an effect on the latitude of publication terms.

Turn now to the control variables. As predicted by transaction-cost logic, transaction attributes play a significant role in determining terms. Monitoring terms are, for the most part, more explicitly specified in transactions where appropriability or moral hazard concerns are greater, such as when material or equipment is supplied by the sponsor. Both access ( $p < 0.10$ ) and reporting terms ( $p < 0.10$ ) are specified in more detail when the sponsor contributes proprietary materials to the research project. The coefficient on equipment is also positive and significant ( $p < 0.05$ ) for access. IP allocation also provides some support for the transaction cost logic as the coefficient on material is positive and significant ( $p < 0.01$ ). The coefficient on equipment, while in the expected direction, does not reach significance. It appears that the sponsor generally makes a greater effort to negotiate the allocation of IP rights when they have valuable intellectual assets at risk. Finally, we find publication constraints are greater when materials are supplied by the sponsor ( $p < 0.01$ ). For the monitoring terms, our findings provide some support for the TCE-based argument that technological uncertainty is associated with less complete contracts. Access terms are less explicitly specified in projects that focus on basic research ( $p < 0.10$ ). This relationship does not appear to hold where Reporting, IP allocation, and Publication terms are the dependent variables. No less detailed IP allocation terms are drafted when the research project is associated with the more technically uncertain basic sciences. This may reflect the increasing location of innovations in “Pastuer’s Quadrant” -- breakthroughs that address fundamental scientific questions while simultaneously having immediate practical implications for commercial products (Stokes, 1997).

Contract duration has a strong positive effect across all four dependent variables. Terms are more explicitly detailed when the period of performance is longer. Surprisingly, project cost has relatively little impact on contract design.<sup>20</sup> In the one case where the BUDGET variable shows significance (ACCESS), the coefficient is negative. Company age significantly influences reporting requirements. Younger firms negotiate agreements with more detailed reporting than do older firms. Interestingly, the coefficient on PI CONTRACTING EXPERTISE is not significant across any of the dependent variables. This finding provides further support that, for PIs, it is the within relationship

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<sup>20</sup> We also ran the estimations with budget and without duration and visa versa. Results were robust.

experience, rather than increased bargaining power accruing to the PIs broader experience, that drives the move to less detailed contracts.<sup>21</sup> TECHNICAL EXPERTISE is significant only with respect to Access – Access terms are less explicitly specified for PIs with stronger research records/reputations.

### **An Extension**

Although our study focuses primarily on role-specific relational learning and directional impact, we are able to provide empirical insights related to previous theoretical work that links organizational type to contract design. While silent on directional effects, Argyres & Mayer (2007) developed propositions about which organizational types are more significant repositories of different categories of contract design capabilities and, thus, are anticipated to play a larger part in the specification of contract terms. First, in proposition 2, Argyres & Mayer (2007: 1068-69) argue that lawyers (contract administrators) will be important players in designing decision and control rights allocation provisions, highlighting IP terms as an often-contested control right. Recognizing, that technical personnel (project managers and engineers) will also have interest in such terms, these authors stop short of proposing that lawyers would necessarily be a more significant repository of contract design capabilities with regard to the allocation of decision and control rights than would technical personnel. Our data allows us to investigate the relative influence these two parties have on IP-related control and decision rights. To enable a direct comparison across coefficients, we estimate a model without logging the Univ-Co History variable followed by the standardization of our two independent variables. We find that the positive significant ( $p < 0.01$ ) coefficient on the Univ-Co History variable is 2.32 times greater than the negative significant ( $p < 0.05$ ) coefficient in the PI-Co History variable. Thus, we find evidence that, in the Sponsored Research setting, contract administrators are indeed a more dominant force on this contractual dimension than are scientists. Second, in proposition 5 Argyres & Mayer (2007:1071) argue that technical personnel (project managers and engineers, in their context), not contract administrators (lawyers, in their context) “will be the primary repositories of a firm’s contract design capabilities with

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<sup>21</sup> This finding is in-line with that of Mayer and Argyres (2004) who note that, at the project management level, the predominant sources of learning were internal to the contractual relationship.

regard to providing for communication between parties.” To investigate this proposition, we re-ran our analysis using finer-grained ACCESS and REPORT dependent variables that included only the communication elements.<sup>22</sup> In this analysis we also no longer log the Univ-Co History variable, but standardize the two key independent variables to enable a direct comparison across coefficients. We find support for the proposition as the coefficient on PI-Co History is approximately 2.5 times greater than the coefficient on Univ-Co History when either Access-IS or Report-IS is the dependent variable.<sup>23</sup> These results are indicative of a greater influence of the technical personnel on this dimension.

### **Robustness Tests**

We adopted a summation approach in the design of our dependent variables, including all related sub-elements identified and giving each sub-element equal weight, except time elements of IP terms. While this is a reasonable default when no grounded reasons exist for excluding or assigning different weights to particular sub-elements, we conducted robustness tests to explore some effects of these variable construction choices. First, we re-coded our dependent variables to weigh less common clauses more heavily.<sup>24</sup> The results for the weighted analysis are consistent with our initial summation approach. Second, we removed the time elements in both of the IP terms.<sup>25</sup> It is possible that timing considerations may be different in character than the proscriptive/restrictive elements of these terms. For ALLOCATE, we recalculated the value of this variable without the score for total exercise/negotiation period. Our results hold for the hypothesized variables (Table 4). For PUBLICATION, the counts for allowable review period were dropped to create a variable that focuses solely on the sponsor’s editorial rights. Using this new PUBLICATION variable, we find additional support for our role-based hypotheses. The

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<sup>22</sup> Access-IS captures the four information sharing sub-elements of access; (1) review meetings between the PI and company scientists will be scheduled; (2) research results will be jointly evaluated and know-how developed will be shared; (3) a company rep. will be specifically named; and (4) a joint scientific advisory board will be formed. Report-IS includes the three information sharing sub-elements: (1) Interim progress reports were called for, (2) Number/dates for delivery of interim reports was specified, and (3) Content elements for the report were outlined.

<sup>23</sup> The coefficients on both PI-Co History and Univ-Co History are significant in a one-tailed test in the Access-IS model, while only the coefficient on PI-Co History is significant in the Report-IS model.

<sup>24</sup> For the weighted analysis, we used a quartile-based weighting system. If 50% or more of the contracts included the clause, the clause was given a weight of 1. If the clause was contained in 25%-50% of the contracts, it was weighted by a factor of 1.5. For clauses included in less than 25% of the contracts a factor of 2 was used.

<sup>25</sup> We also re-ran the analysis using a 0/1 indicator for the specification of a review period (regardless of length of the review period). Our results remain stable under this specification as well.

delineation of specific editorial rights for the sponsor decreases when the PI and the company have previously engaged in research projects (the coefficient on PI-Co History is negative and significant,  $p < 0.01$ ) and increases the greater the number of prior research agreements conducted between the university and a particular firm (the coefficient on Univ-Co History is positive and significant,  $p < 0.10$ ).

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Insert Tables 4 and 5 about here  
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To assess whether scientists' interest in IP rights differ across IP elements, we segmented the allocation variable by sub-terms into the three, non-time related categories: option expansiveness, licensing framework, and unobstructed rights. Interviews with university scientists and administrators indicated scientists are interested and do have a say in these three IP categories. The option exercise and negotiation periods category was not included, as scientists appear to be least concerned with and least likely to influence this category. The category that our interviews suggest university scientists are most concerned with is unobstructed rights. Scientists want to be sure 1) they are not restricted from engaging in other sponsored research projects, 2) they would not be precluded from using data generated through the project even if ownership is given to the sponsor, and 3) any IP previously developed outside the relationship, used to advance the project, remains their property. Analysis of these three categories independently shows that scientists do not significantly reduce the use of items conferring unobstructed rights as experience accumulates (see Table 5). In the remaining two categories our hypothesized relationship is substantiated. Options and license elements that impact potential financial returns are specified early but become less detailed over time in the relationship between the scientists and company.

## **DISCUSSION AND CONCLUSION**

In this study of university-industry sponsored research agreements, we investigate how organizational roles shape relational learning, which subsequently impacts contract design. Semi-structured interviews with university scientists and contract administrators involved in multiple contracts informed hypothesis development, while content analysis of a stratified sample of repeated contracts

provided rare and detailed data to test hypothesized relationships. Drawing on the contracting literature, behavioral theory, and our interviews, we develop logic in support of directional effects on the evolution of enforcement provisions resulting from differential relational learning of two organizational roles.

Our study makes two main contributions to the contracting literature. First, the study highlights how role-based directional learning influences contract evolution when multi-point contacts jointly negotiate cross-boundary agreements. Applying behavioral theory, we posit that the role of organizational members jointly involved in relational contracting direct different members' attention to certain elements of the contract, trigger different search rules and result in different kinds of learning. We argue that as scientists gain contracting experience with an exchange partner their focus of attention on knowledge creation supports the establishment of a relationship based on technical competence, behavioral experience, and operational routines that cause the enforcement terms of subsequent contracts to become less detailed. We also submit that contract administrators, because of their focus on knowledge protection, primarily accumulate joint governance experience and establish administrative routines which cause the enforcement terms of subsequent contracts to become more detailed. Contracts can evolve via additions or deletions of terms, and role-specific learning is key to understanding the overall evolutionary trajectory. Second, we provide the first empirical test of simultaneous, directional impacts of multiple organizational roles on contract design. Taking advantage of the multi-point contacts of our sample of sponsored research agreements, we found statistical support for our hypothesized directional learning effects and evidence of significant practical impact in the specification of both monitoring and intellectual property right terms.

An ancillary benefit of our study is the ability to shed light on relationships that have been previously postulated in the contracting literature, but not yet tested. Our detailed metrics allow us to conduct preliminary empirical analysis of Argyres and Mayer's (2007) theoretical reasoning about which organizational types will serve as the more significant repositories of specific contracting capabilities, by assessing whether contract administrators or scientists play a larger part in the specification of control rights and communication terms. Initial findings are supportive of organizational type-contractual

design capabilities links, and the relative influence on contract terms anticipated. In sum, our study speaks to both directional and relative impact of role-specific learning on contract evolution.

Like most research, this study has a number of empirical limitations that provide direction for future research. First, in an effort to control organizational characteristics, we limited our study to the research agreements of a single university. Though we are confident this university is an excellent representative for the population of top academic research universities with highly esteemed medical schools, we encourage research that would replicate our results with other universities, and other not-for-profit and for-profit organizations. Second, due to the fine tuned nature of our measures, the need to collect the actual contracts, and the time required to analyze each contract, our sample size is completely adequate but not extensive. We believe our stratified technique for sample selection helps to assure the representativeness of our results and that our robustness tests increase the confidence of our findings. However, future research with larger samples is encouraged. Third, our detailed focus of two key terms – monitoring and IP rights – is also a limitation that needs to be addressed in future research. The question remains as to whether our findings relating contract evolution to experience at different relationship points is generalizable beyond enforcement provisions to definitional and contingency planning aspects of contracts. Fourth, we cannot completely rule out the possibility that the bargaining power of a company changes as it has more projects with the university. However, university contract administrators reported that they start negotiations with the previous contract used with this company, and often deal with many different people across a large firm. These comments suggest that company bargaining power is not a major factor in the contract structure of sponsored research agreements.

Our findings have implications for future research. First, in our study, relational learning across the different organizational roles influenced the specifications of the contracts in different directions. This reinforces prior work that has argued that contracting is a complex activity and illustrates the need for more multi-point research related to contract specification. Our study argues for more research that explicitly considers how relational learning accumulates in different locations within organizations. Appreciation of the path dependent, yet dispersed, accumulation of learning is likely to have significant

implications for understanding how organizations leverage, transfer, and store relevant contracting knowledge. Second, the repeated ties count measures used in this study could be improved upon through a more in-depth case study that better captures learning mechanisms. Third, additional research incorporating data on performance is needed. The arguments posed regarding both the influence of relational and transaction attributes on contract design are driven by performance expectations. There is a need to empirically investigate whether the positive performance expectations hold for less specification of the contract by scientists and more specification of the contract by contract administrators as the relationship evolves. Finally, research considering the generalizability of our findings would also be valuable. Although corporate sponsored academic research is significant, other forms of cross-boundary alliances are also prevalent as sources of knowledge required for innovation and new product development. We believe that the concept of role-based directional learning in contract design hold in other contexts where multi-point contacts jointly negotiate cross-boundary agreements. Research is needed to establish the extent to which relational learning accumulates in various organizational roles and how different roles affect the evolution of different contract terms.

In this paper, we explore how monitoring terms and intellectual property terms of corporate sponsored university research agreements are influenced by contractors' organizational roles. Analyzing corporate sponsored university research agreements, we find support for our theoretically-grounded hypotheses. We find that the scientists' role is unique and provides a strong theoretical and empirical illustration of the learning processes that can lead participants in relational contracts to choose to delete contract terms over time. However, there is much work yet to be done. It is our hope that the rationale we put forth and our findings will encourage further research that will provide a deeper and richer understanding of the complex, multiple-point relationships that evolve in cross-boundary innovation-based relationships.

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TABLE 1

**Sponsored Research Agreement Contract Clause Frequency (No. of Contracts: 136)**

	#	%
<b>Company Access</b>		
The sponsor will be given access to data generated	80	58.82%
A company representative will be specifically named	45	33.09%
The sponsor will be allowed to visit the research site	31	22.79%
Review meetings between the PI and the company scientists will be scheduled	22	16.18%
Research results will be jointly evaluated and know-how developed will be shared	17	12.50%
A joint scientific advisory board will be formed	1	0.74%
<b>Reporting Requirements</b>		
A final report was required	109	80.15%
Interim progress reports were called for	89	65.44%
Number/Dates of delivery for interim reports specified	49	36.03%
Content elements to be included in the report outlined	30	22.06%
PI required to maintain records documenting project activities	20	14.71%
<b>IP Allocation</b>		
Option Offered	124	91.18%
Option Expansiveness (Category 1)		
Worldwide	104	76.47%
Exclusive	122	89.71%
Sub-License Rights	40	29.41%
Perpetual	10	7.35%
Option Exercise and Negotiation Periods (Category 2)		
None Specified	19	13.97%
3 Months	28	20.59%
6 Months	51	37.50%
9 Months	24	17.65%
12 Months or More	14	10.29%
Licensing Framework (Category 3)		
Parameters for acceptable license terms	38	27.94%
Process for license term negotiation	6	4.41%
Right of first refusal to license on terms negotiated with a third-party	39	28.68%
Unobstructed Rights (Category 4)		
Warranty clause -- No third-party has rights to the IP	43	31.62%
Restrictions on the PI's right to engage in other sponsored research projects	26	19.12%
Specification that the sponsor owns the data generated through the project	34	25.00%
Previous conceptions reserved	39	28.68%
<b>Publication Constraints</b>		
Specified review and delay period		
None specified	4	2.94%
Up to 90 days	92	67.65%
Between 91-120 days	35	25.74%
Between 121-150 days	2	1.47%
More than 150 days	3	2.21%
Right to comment	36	26.47%
Right to delay given content concerns	4	2.94%
Right to require revisions	4	2.94%

**TABLE 2**  
**Descriptive Statistics**

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
1 Access	1																			
2 Report	0.26	1																		
3 Allocate	0.47	0.33	1																	
4 Publication	0.11	0.22	0.20	1																
5 Material	-0.04	0.17	0.26	0.16	1															
6 Equipment	0.30	-0.09	-0.06	-0.11	-0.37	1														
7 Basic	-0.22	-0.17	-0.08	-0.06	0.16	0.12	1													
8 Pi-Co History	-0.08	-0.13	-0.16	-0.14	-0.02	0.10	0.13	1												
9 Univ-Co History (Ln)	0.18	0.00	0.23	0.01	0.00	0.06	-0.02	0.15	1											
10 Dept. Composition	-0.02	-0.11	0.01	-0.13	0.22	0.12	0.61	0.18	-0.08	1										
11 PI Contracting Expertise	0.04	-0.01	-0.12	-0.20	-0.09	0.04	0.05	0.23	-0.07	0.03	1									
12 PI Technical Expertise	-0.21	0.17	0.15	0.09	0.27	-0.15	0.20	-0.10	-0.04	0.23	-0.09	1								
13 Duration (mo.)	0.24	0.42	0.30	0.32	-0.10	-0.12	-0.09	-0.05	-0.15	-0.11	0.00	0.18	1							
14 Budget (Ln)	-0.14	0.21	0.12	0.06	0.13	-0.25	0.11	-0.07	-0.10	0.06	0.02	0.13	0.37	1						
15 Age	-0.16	0.27	-0.01	-0.06	0.12	-0.29	-0.09	0.09	-0.48	-0.16	0.26	0.01	0.25	0.20	1					
16 University Experience (Ln)	0.19	-0.02	0.04	-0.14	-0.15	0.21	-0.01	0.39	0.38	0.00	0.39	-0.30	0.00	-0.12	0.09	1				
17 Time1 (1994-1997)	-0.12	0.01	-0.03	0.09	0.13	-0.08	0.00	-0.32	-0.32	0.06	-0.29	0.26	-0.11	0.01	-0.07	-0.83	1			
18 Time2 (1998-2001)	-0.18	-0.05	0.01	-0.01	0.09	-0.19	0.16	-0.04	0.05	-0.03	-0.11	0.00	0.07	0.15	0.00	0.12	-0.52	1		
19 Time3 (2002-2005)	0.29	0.04	0.01	-0.09	-0.23	0.28	-0.18	0.34	0.25	-0.05	0.39	-0.25	0.03	-0.17	0.06	0.66	-0.39	-0.57	1	
<b>Summary Statistics</b>																				
Mean	1.43	2.17	5.57	1.68	0.43	0.15	0.52	0.76	1.35	0.44	2.06	6.42	15.15	10.58	0.57	6.02	0.29	0.41	0.31	
Standard Deviation	1.28	1.31	2.65	0.93	0.50	0.36	0.50	1.04	1.18	0.26	2.35	6.53	11.78	2.38	0.84	0.69	0.46	0.49	0.46	
Min.	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	4.24	0	0	0	
Max.	5	5	11	7	1	1	1	4	4.42	1	14	32.33	60	14.22	2	6.86	1	1	1	

**TABLE 3**  
**Contract Terms Analysis**  
 SUR; Underlying Specification: Ordered Logit  
 Standard Errors Clustered by Company

	Access			Report			Allocate			Publication		
	Coef.	s.e		Coef.	s.e.		Coef.	s.e.		Coef.	s.e.	
<i>Independent Variables</i>												
H1: Pi-Co History (Count)	-0.494	0.287	*	-0.283	0.139	*	-0.518	0.164	**	-0.130	0.154	
H2: Univ-Co History (LN)	0.394	0.231	*	0.446	0.282	+	0.678	0.237	**	-0.159	0.222	
<i>Control Variables -- Transaction Attributes</i>												
Material	1.110	0.578	+	0.814	0.434	+	1.386	0.460	**	1.253	0.446	**
Equipment	1.936	0.818	*	1.010	0.695		1.024	0.840		-0.493	0.700	
Basic (Using individual w/ PhD Dummy)	-1.169	0.666	+	-0.671	0.427		-0.478	0.541		-0.113	0.646	
<i>Control Variables -- Other</i>												
Duration	0.092	0.029	**	0.072	0.018	***	0.072	0.019	***	0.079	0.030	**
Budget(LN)	-0.173	0.083	*	0.063	0.117		-0.034	0.099		-0.085	0.063	
Age	-0.378	0.375		0.865	0.367	*	0.286	0.292		-0.745	0.476	
University Experience (LN)	-0.125	0.986		-0.121	0.652		0.208	0.718		0.614	0.921	
PI Contracting Expertise	0.087	0.126		-0.006	0.077		-0.048	0.088		-0.124	0.106	
PI Technical Expertise (Cites/Pubs)	-0.106	0.035	**	0.029	0.038		-0.008	0.032		0.009	0.034	
Department Composition (% faculty w/ PhD)	2.094	1.153	+	-0.001	1.085		1.241	0.598	*	-0.837	1.305	
Time1	-0.593	1.487		0.117	0.923		0.191	1.292		0.559	1.149	
Time2	-0.853	0.628		-0.271	0.585		-0.227	0.751		-0.316	0.680	
Number of Observations	136			136			136			136		

\*\*\*p<0.001; \*\*p<0.01; \*p<0.05, +p<0.10

Significance is one-tailed for hypothesized variables and two-tailed for control variables

**TABLE 4**  
**IP Terms with Time Elements Omitted: Robustness Test**  
 SUR; Underlying Specification: Ordered Logit

<i>Independent Variables</i>	Allocate		Publication			
	Coef.	s.e.	Coef.	s.e.		
H1: Pi-Co History (Count)	-0.467	0.187	**	-0.514	0.201	**
H2: Univ-Co History (LN)	0.805	0.261	**	0.404	0.277	+
<i>Control Variables -- Transaction Attributes</i>						
Material	1.084	0.463	*	0.892	0.566	
Equipment	1.241	1.033		0.649	0.926	
Basic (Using individual w/ PhD Dummy)	-0.708	0.698		0.316	0.654	
<i>Control Variables – Other</i>						
Duration	0.063	0.022	**	0.068	0.028	*
Budget(LN)	-0.025	0.091		-0.133	0.057	*
Age	0.323	0.328		-0.361	0.514	
University Experience (LN)	0.058	0.675		0.868	0.779	
PI Contracting Expertise	0.045	0.088		-0.176	0.152	
PI Technical Expertise (Cites/Pubs)	-0.017	0.033		0.008	0.039	
Department Composition (% faculty w/ PhD)	1.511	0.844	+	-1.979	1.206	+
Time1	0.628	1.219		1.817	1.194	
Time2	0.155	0.767	*	0.599	0.805	
Number of Observations	136			136		

\*\*\*p<0.001; \*\*p<0.01; \*p<0.05, +p<0.10; Significance is one-tailed for hypothesized variables & two-tailed for controls

**TABLE 5**  
**IP Allocation by Categories**  
 SUR; Underlying Specification: Ordered Logit

<i>Independent Variables</i>	Allocation: Option Expansiveness		Allocation: Licensing Framework		Allocation: Unobstructed Rights				
	Coef.	s.e.	Coef.	s.e.	Coef.	s.e.			
H1: Pi-Co History (Count)	-0.499	0.176	**	-0.293	0.186	+	-0.150	0.186	
H2: Univ-Co History (LN)	0.867	0.284	**	0.486	0.258	*	0.312	0.200	+
<i>Control Variables -- Transaction Attributes</i>									
Material	0.182	0.397		1.424	0.516	**	0.696	0.531	
Equipment	-0.597	0.825		1.680	0.807	*	0.765	0.925	
Basic (Using individual w/ PhD Dummy)	-0.869	0.700		-0.132	0.562		-0.526	0.861	
<i>Control Variables -- Other</i>									
Duration	0.032	0.024		0.066	0.021	**	0.045	0.023	+
Budget(LN)	0.020	0.073		-0.099	0.082		0.012	0.074	
Age	0.479	0.356		0.559	0.408		-0.442	0.379	
University Experience (LN)	0.018	0.669		0.866	0.595		-0.518	0.606	
PI Contracting Expertise	0.084	0.081		0.004	0.104		0.040	0.078	
PI Technical Expertise (Cites/Pubs)	-0.002	0.033		0.032	0.046		-0.043	0.055	
Department Composition (% faculty w/ PhD)	1.977	0.853	*	-0.810	1.133		1.325	1.093	
Time1	0.683	1.101		2.033	1.002	*	-1.027	1.151	
Time2	-0.234	0.666		0.719	0.563		-0.286	0.687	
Number of Observations	136			136			136		

\*\*\*p<0.001; \*\*p<0.01; \*p<0.05, +p<0.10; Significance is one-tailed for hypothesized variables & two-tailed for controls