

Contracting for Knowledge Exchange: An Empirical Investigation of IT Sourcing Arrangements

Ramanath Subramanyam

rsubrama@illinois.edu

University of Illinois at Urbana-Champaign

1206 S. Sixth St, Champaign, IL – 61820

Anjana Susarla

asusarla@u.washington.edu

University of Washington

336 Mackenzie, Box 353200, Seattle, WA – 98195

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***Abstract:** Increasingly firms are relying on external sourcing for access to critical knowledge assets. This paper focuses on the key challenge in designing contracts that can enable knowledge exchange and protect key knowledge assets, whilst simultaneously providing incentives for inter-organizational learning and knowledge recombination. Integrating explanations from incomplete contracting theory and prior knowledge-based research, we analyze a sample of IT outsourcing contracts to investigate the extent to which contract design characteristics vary with the nature of the task and knowledge asymmetries between the parties. We specifically analyze the role of ex ante design of coordination mechanisms, allocation of decision rights to protect key knowledge, as well as the incentive structure in the contract.*

Keywords: Knowledge Exchange, Learning, IT Outsourcing, Incomplete Contracting

1. Introduction

Competitive advantage is increasingly determined by the creation and possession of valuable knowledge¹ rather than through access to inexpensive labor and raw materials alone (Barney 1991). A large body of organization theory and strategic management literature has focused on the discrete choice between hierarchies and markets as means to organize firm activities through the prism of organizational capabilities and the knowledge-based view of the firm (e.g., Barney 1991, Prahalad and Hamel 1990, Kogut and Zander 1992, Grant 1996). This literature, however, is primarily focused on organizational forms as means of economizing on knowledge exchange and internalizing knowledge. This stream of research is relatively silent on the role of opportunism which is a serious threat in knowledge based exchanges. Conversely, a substantial body of research in economics exclusively focuses on the firm boundary choice in terms of concerns of ex-post opportunism, while ignoring the need for knowledge exchange and recombination of tacit and explicit knowledge across organizational boundaries.

Knowledge exchange and recombination involve solution search across complex solution spaces and recombining knowledge to facilitate problem solving, which creates barriers to external sourcing in terms of monitoring the misuse of illegally-gained knowledge, ambiguous definition of ownership, difficulty in enforcing property rights, and limitations of trade secret protections in the context of explicit

¹ In this paper we define knowledge as information whose validity has been established through tests of proof (consistent with Liebeskind 1996). The term includes explicit forms of knowledge, evident from codified knowledge artifacts such as patents, design documents, and blueprints as well as tacit knowledge such as what is involved in organizational routines that help firms produce goods effectively and efficiently.

as well as tacit knowledge (Liebeskind 1996). Due to the specialized nature of knowledge and the need to bear sunk costs, contracting for knowledge exchange is especially fraught with concerns about ex post opportunism. Scholars therefore view markets as undesirable in sourcing knowledge due to their costs in enforcement (e.g., Williamson 1991). However, the literature has often overlooked the fact that outsourcing provides access to capabilities that do not exist internally (e.g., Jacobides and Winter 2005). A noteworthy example is that of Boeing Corporation, which created a global collaboration model delegating a considerable amount of innovation and design responsibilities to suppliers and collaborating with them in this process (Nolan and Kotha 2005). Such inter-firm arrangements confer tremendous benefits in terms of speedy access to external capabilities that allow firms such as Boeing to both exploit internal capabilities as well as enhance innovativeness by learning from external partners. However, the risk in such exchanges is that the complexity of the underlying task and the proprietary nature of Boeing's knowledge considerably increase Boeing's risks of losing competitive advantage and future bargaining power. Given the risk of appropriation of knowledge assets, there is need for extensive contractual safeguards that prevent opportunistic behavior from their suppliers, which should be in conjunction with mechanisms that promote knowledge exchange and collaborative behavior that are reminiscent of hierarchy. Indeed, scholars have noted (e.g., Conner and Prahalad 1996) that, for market-based transactions involving considerable knowledge exchange, contracts would need to possess certain characteristics of employment contracts.

The context for this study is the global market for outsourced IT services, which was estimated in 2006 at over \$716 billion with an anticipated compound annual growth rate (CAGR) of 7% (DataMonitor 2007). Recent years have witnessed a tremendous growth in external sourcing of innovative information systems that involve potentially rent-generating knowledge assets (Forrester 2007). Outsourcing of IT can increase the rate at which firms adopt technological innovations (e.g., von Hippel 1988, Sivadas and Dwyer 2000) and provide access to scarce technological expertise. Information systems are highly specific to organizations, being inextricably linked with knowledge of business processes within the firm that outsources IT services (that we, henceforth, refer to as the client or buyer) and knowledge of the

organizational context (Bassellier and Benbasat 2004), which can be characterized as embodying ‘tacit’ organizational knowledge (e.g. Kogut and Zander 1992). Clients and vendors possess different competencies (Levina and Ross 2003) as well as different knowledge bases. Particularly, the client firm possesses knowledge of the domain of the task while the vendor firm possesses the “know-how” related to the technological solution to fulfill the client firm’s needs. A successful IT outsourcing agreement involves learning and knowledge transfer across the client and vendor as well as a recombination of complementary knowledge of the client and the vendor. This poses a considerable challenge to contracting for two reasons. First, communication of requirements between a client and vendor is rendered difficult due to the need for situated, local knowledge that is often embedded in informal routines and capabilities. Second, the presence of informal knowledge creates a moral hazard problem in the outsourcing of knowledge intensive tasks since the effort made by the vendor to engage in learning is difficult to ascertain and the effort exerted by the client firm in providing the necessary complementary knowledge is also essential to the performance of the vendor. Indeed observers have noted that barriers to the transfer of knowledge might significantly erode the gains from IT outsourcing (Overby 2004).

In this paper, we examine the role of contract design in inter-firm agreements involving knowledge transfer and recombination, building upon theories on incomplete contracting and knowledge. Specifically, we focus on the three inter-linked challenges posed by external sourcing of knowledge intensive tasks: (1) that of aligning incentives, (2) creating mechanisms for smooth knowledge exchange and inter-organizational learning, while simultaneously (3) guarding against misappropriation by an exchange partner. We posit that the choice of coordination mechanisms, allocations of decision rights to protect against intellectual property appropriation, and appropriate levels of incentive intensity, together, are likely to mitigate the problems caused by incompleteness in such contracts, while ensuring that the objectives of learning and knowledge protection are met. We find that the structure of inter-organizational contracts adopted by the client-vendor dyad vary with the knowledge-intensiveness of the task as well as the pre-existing knowledge advantages of the partner (both codified and tacit forms) relevant to the contracted task. We find that firms craft explicit coordination mechanisms at the onset of the sourcing

agreement to circumvent the moral hazard problems in knowledge transfer. We also examine the incidence of mechanisms to protect against intellectual property misappropriation when knowledge assets are involved. Further, we examine the relative importance of these three contract design choices (coordination mechanisms, incentives, and intellectual property restrictions) in knowledge-based contractual arrangements. Finally, while earlier works on IT contracting have explored the make vs. buy tradeoff (e.g., Mayer 2006, Mayer and Salomon 2006), our method of data gathering relies on examining actual formal contract documents that govern agreements between firms to infer contract design implications.

This paper can make the following contributions to literature. Despite growth in the outsourcing of innovative activities, design of contracts that govern such activities has not received attention in prior literature. Limited attention has also been devoted to understanding the knowledge component of outsourced tasks, especially those involving technology transfer or recombination. One of the contributions of this paper is to highlight the incompleteness of such contracts and the need to create ex-ante contract designs to enable inter-firm learning despite the presence of potentially rent-generating knowledge assets, which create potential for opportunism. We use arguments from property rights theories and the knowledge-based view of the firm to articulate the potential problems of moral hazard and imperfect commitment (Milgrom and Roberts 1992) caused by the knowledge intensiveness of the outsourced task, the level of tacit knowledge required from the transacting parties, as well as difficulties in the transfer of ‘sticky’ local knowledge (e.g., von Hippel 1998) embedded in organizational routines and information channels (e.g., Henderson and Clark 1990). We find support for the view that, despite the difficulty of enforcing contractual parameters, exchanges involving considerable knowledge need to possess certain characteristics of employment contracts (e.g., Conner and Prahalad 1996).

2. Theory and Hypotheses

2.1 Knowledge transfer and inter-firm exchange

When two firms enter into an inter-organizational relationship involving knowledge transfer, both codifiable and tacit knowledge need to be exchanged between the two parties. The effectiveness of a

knowledge-intensive outsourcing arrangement depends on the learning by the vendor about the client firm and the recombination of the client's domain knowledge and the vendor's solution knowledge. This implies the following three challenges in inter-firm arrangements. First, knowledge transfers involve an iterative process of exchange, which is a result of direct, extensive interactions, such as face-to-face interactions (Arrow 1974, Marsden 1990). Thus, knowledge transfer and exchange involves causal ambiguity (e.g., Lippman and Rumelt 1982) that increases the difficulty in inter-firm communication (e.g., Argote 1999), leading to contract incompleteness. Second, the difficulty in determining whether all the contractual obligations are fulfilled raises the potential for moral hazard and post-contractual bargaining (Milgrom and Roberts 1992). Property rights arguments suggest that the allocation of rights (used to generate residual surplus) depends on the contractability of knowledge assets (e.g., Alchian and Demsetz 1972, Grossman and Hart 1986). Hence, the extent to which the knowledge involved in the exchange is tacit plays a key role in the allocation of rights and restrictions that safeguard against misappropriation of knowledge. Prior research suggests that when tacit knowledge of parties is crucial for a jointly created output, price and authority are unsuitable for motivating the parties and organizational forms that emphasize participation, such as overlapping teams, are needed (Osterloh and Frey 2000). Hence contracts involving exchange of tacit knowledge may need to possess characteristics resembling a vertical exchange such as steering committees and jointly managed personnel overseeing the fulfilment of the obligations that promote participative and collaborative behavior from the exchange partner. Conversely, the more codifiable the knowledge, the easier it is to specify the contingencies and the resulting contract is likely to specify the restrictions that protect against misappropriation. We examine restrictions such as conditions of non disclosure, limitations on the modifiability of the product, constraints on redeployment and usage restrictions on the product in the context of knowledge-intensive exchanges. Third, both the client and the vendor need to possess the requisite absorptive capacity (Cohen and Levinthal 1990) and combinative capabilities (Kogut and Zander 1992) that are required for effective knowledge transfer and recombination.

Knowledge intensive IT outsourcing arrangements require the following: (i) effective and efficient recombination of client knowledge (domain knowledge) with vendor knowledge (solution knowledge) (ii) iterative search across potentially large solution spaces to conceptualize a solution to an organizational (client firm) problem (iii) incentivizing exchange partners for learning and knowledge transfer while simultaneously protecting against appropriation and (iv) limiting concerns of opportunism due to the ex-ante knowledge asymmetries and private knowledge. Contractual remedies in the presence of incompleteness include alignment of incentives of the two parties, investments in coordination efforts, and allocation of ownership rights to the contracted artifacts. This paper focuses on the design of contract structures to achieve these objectives. Next, we examine these remedies in greater detail keeping in mind the characteristics of knowledge.

<Insert Figure 1 about here>

2.2. Knowledge Transfer and Inter-firm Coordination mechanisms

In the presence of complementary partner knowledge, the contract structure is a strategic choice that involves design decisions with innovation attributes. We explore the need for inter-firm coordination with *two aspects* of knowledge: (i) *task-specific*: greater knowledge intensiveness of the task, which would require inter-firm learning and knowledge transfer, and (ii) *partner specific*: the vendor's (solution) knowledge advantage, which might confer bargaining power on the vendor since this knowledge needs to be recombined with the domain knowledge of the client firm.

For knowledge intensive tasks, the vendor needs to learn about the organizational context and the client needs to work with the vendor. Hence, joint learning is important and frequent iterations are required between the two parties to achieve the contractual objectives. Knowledge intensiveness increases the difficulty in means ends transformations and causal ambiguity of tasks. In the presence of uncertainty in the means-end transformation process, it is essential that parties to the contract identify local efficiencies that enhance problem solving. For exchanges involving complex knowledge transfer, problem solving is likely to involve heuristic search that requires coordinated decisions, where the role of formal contracts incorporating these local efficiencies is central to the coordination process (Milgrom and

Roberts 1992). Inter-organizational arrangements to facilitate learning and knowledge transfer can ameliorate the transfer of local knowledge (e.g., Zollo, Reuer and Singh, 2002). The joint learning and knowledge sharing between firms (e.g., Kale, Singh and Perlmutter, 2000) as well as joint problem solving arrangements (e.g., Dyer and Singh 1998) enhance the value of the inter-organizational exchange. Similarly, Dyer and Singh (1998) posit that transacting partners get to know where critical (tacit) expertise resides within each firm. Coordination mechanisms such as steering committees and joint management teams (boundary spanning coordination mechanisms) serve the purpose of specifying and codifying the business processes that would accompany the agreement. Steensma and Corley (2000) suggest that for certain tasks such as simple technology licensing agreements (which do not involve recombination or knowledge exchange), unilateral transfer of knowledge without much interdependence is more likely, whereas for certain knowledge intensive tasks bilateral collaboration and joint learning are more necessary. Joint learning is more important when dealing with processes that involve tacit routines when it is difficult to spell out detailed contractual procedures (Anand and Khanna 2000a). We also posit that the newer the knowledge that is generated, the less likely it is to be codified and greater the interactions among the involved parties to enable transfer of knowledge. Successful fulfillment of such a contract would require that coordination arrangements be made prior to the commencement of work processes. These coordination mechanisms might reduce the reliance of client firms on output measurement, which could be particularly daunting given the complexity of the solution space and the inherent difficulty in performance measurement. When an agreement involves a vendor who possesses a priori knowledge advantage over the client firm, there is a possibility of opportunism and tension that might limit the effectiveness of the recombination of vendor and client knowledge. Thus, the lack of inter-firm coordination mechanisms can encourage opportunistic behavior as well as shirking from either of the transacting parties. Thus, we hypothesize that:

Hypothesis 1a: Inter-firm contracts for tasks with a greater knowledge component will be associated with the presence of more ex-ante specified coordination mechanisms.

Mayer and Argyres (2004) maintain that inter-organizational learning takes place through an iterative and incremental process whereby parties accumulate a shared repository of knowledge (consistent with Arrow 1974, Marsden 1990). The effectiveness of such knowledge transfer and recombination is enhanced when there is greater absorptive capacity (e.g., Cohen and Levinthal 1990) in the receiver and when there is a similarity in the knowledge bases of both firms (e.g., Lane and Lubatkin 1998). When there is a greater tacit component of the knowledge, prior research posits that the two transacting organizations would need to work together in setting up processes for joint problem-solving (e.g., Nonaka 1994). Recombination of existing knowledge is more difficult for exchanges involving tacit knowledge, where both client and vendor may need to engage in a heuristic and iterative search process among the solution alternatives; thus, mechanisms such as price and authority are less likely to be successful governance devices (Osterloh and Frey 2000). Instead, organizational forms such as overlapping teams and joint management agreements may be more beneficial. Hence, in settings where the vendor possesses an a priori advantage, we expect that contracts would involve pre-specified coordination mechanisms to enable creation of joint output. Of course, if the client firm possesses the tacit knowledge advantage, the very reason for entering into the contract would be weak, unless extraneous market conditions and cost considerations alone drives the client firm to enter into the relationship. In summary, we hypothesize that:

Hypothesis 1b: The greater the tacit knowledge advantage of the vendor, the greater the likelihood of ex-ante coordination mechanisms specified in the contract.

2.3. Intellectual Property Restrictions

The imperfect appropriability (Arrow 1962) and the public good aspect of knowledge make it difficult to deploy sufficient legal protection mechanisms against knowledge expropriation (e.g., Leibeskind 1996). The property rights view of Grossman and Hart (1986) and Hart and Moore (1990) posits that residual control rights over assets provide incentives for ex-ante investments through efficient distribution of ex-post bargaining power of parties. By defining ex-ante allocation of control rights of each partner over the residual assets, such as access to sequential outcomes, partners can limit the risks of opportunistic behavior. For instance in the context of biotechnology firms, Lerner and Merges (1998) observe control

rights which identify rights during the patent litigation process; they also observe instances where the firm with the greater bargaining power possesses the rights to the contract artifacts and byproducts. Similarly, in the context of knowledge intensive services, we examine the allocation of ownership rights that could address the potential for opportunism in an exchange.

Prior research in incomplete contracting argues that when the holder of the knowledge asset retains the rights to the intellectual property, it can limit the likelihood of expropriation of knowledge by the learning firm (Aghion and Tirole 1994). We focus on three types of contract terms that protect the client firm against appropriation of knowledge assets by the vendor: contractual restrictions on the product(s)/services, intellectual property protection clauses and non-disclosure agreements. When fulfillment of obligations require critical knowledge from one party, the contractual structure is likely to have characteristics of an employment contract, such as inclusion of non-disclosure provisions and intellectual property restriction clauses (e.g., Liebeskind 1996). Further, intense collaborations and highly innovative tasks necessitate greater safeguards against misappropriation of competitive knowledge. Contractual restrictions on activities that are permitted (e.g., Holmstrom and Milgrom 1994) bolster incentives to the vendor to exert non-contractible effort that the vendor would not have otherwise done (e.g., Brickley 1999). Intellectual property protection clauses and nondisclosure clauses can protect one partner from opportunistic holdup by the other (e.g., Hart and Moore 1999). Thus, we hypothesize that:

Hypothesis 2a: Inter-firm agreements for tasks with a greater knowledge component will be associated with stronger intellectual property protection restrictions specified ex-ante.

When the vendor possesses the advantage in the explicit knowledge related to the contracted task, the vendor has accumulated a codifiable knowledge stock prior to the contract in the form of patents, design documents, blueprints, software design patterns, software code, and the like. This stock of codified knowledge, which is further enhanced by the current knowledge exchange, leads to competitive advantage for the vendor and a source of valuable rents in other settings outside the boundaries of the client firm. Given the competitive nature of the IT services industry, we expect that vendors will aggressively protect this key asset in a relationship. The codifiability of the knowledge makes it possible

to specify the rights of the parties, explicate ownership rights, and specify the permissible mechanisms for using the knowledge stock.

Hypothesis 2b: The greater the explicit knowledge advantage of the vendor, the greater the likelihood of IP restrictions specified ex-ante.

2.4. Explicit Incentives

Economics literature on incentives (e.g., Milgrom and Roberts 1992, p221)) argue that the intensity of incentives in an agreement should be a function of measurability (precision) of performance, among other factors such as risk averseness of agent and profitability of incremental effort. Knowledge intensive tasks increase the imprecision of measurement of performance. Hence, the extent to which incentives are provided to the partner should reflect this aspect. Knowledge-intensiveness also increases causal ambiguity (e.g., Lippman and Rumelt 1982), which can create a moral hazard problem since the effort made by the vendor to engage in learning is difficult to ascertain.

When there is uncertainty in the contracting environment, it will be optimal to offer high-powered incentives to the vendor (e.g., Prendergast 2002). Similarly, when a task involves significant knowledge contributions from one party, and if we assume that these contributions will be hard to assess precisely, a high powered incentive scheme is likely to encourage better performance from that party. A high-powered incentive contract, while providing cost certainty to the client, offers strong incentives for the vendor to exert effort since the vendor is the residual claimant who enjoys the surplus from cost saving effort (Grossman and Hart 1983). With a low-powered incentive contract, on the other hand, the vendor has less incentive to reduce costs incurred to clients and hence increases the risk borne by the client. When a (client) firm is knowledgeable about the technology, systems architecture and other inputs to the process of systems development, it can implement effective monitoring and behavioral controls to prevent shirking (e.g., Alchian and Demsetz 1972, Eisenhardt 1985).

An appropriately designed incentive system can align the interests of two parties in a contract and limit conflicts of interest and opportunistic behavior. Specifically, a high-powered incentive would be preferable when precision of outcome measurement is high. High-powered incentives more closely link

pay with performance and enhance effort exerted by the vendor (Poppo and Zenger 1998). We expect that measurement of output is *difficult* in exchange settings where considerable knowledge exchange and technological uncertainty are involved. Factors increasing the complexity of the solution space include the lack of knowledge of means-ends transformations, multiple possible paths for arriving at a satisfactory solution, the increased scope of the outsourcing initiative (e.g., Oxley and Sampson 2004), and the extent to which *new* knowledge is required vis-à-vis recycling of existing knowledge. Based on these arguments, we hypothesize that:

Hypothesis 3a: Inter-firm agreements for tasks with a greater knowledge component will be associated with low powered incentives.

The ability to generate future rents from solution knowledge provides significant bargaining power to the vendor in the contractual negotiations and might increase the possibility of opportunistic behavior. Arguments in favor of the property rights theory would suggest that, in this scenario, the client firm is better off by granting the rights to the residual asset to the vendor (e.g., Aghion and Tirole 1994). This is because the importance of the asset to the vendor will induce the vendor to exert effort and the vendor is likely to self-regulate her/his behavior. When a client firm possesses prior knowledge valuable to the relationship, imposing prohibitive restrictions on the key intellectual assets might alleviate concerns of expropriation but at the same time, they are likely to provide *disincentives* to the vendor and limit effortless exchange. This argument leads us to hypothesize that contracts where vendors possess ex-ante advantage with respect to explicit knowledge are likely to be associated with high-powered incentives. This is further corroborated by the fact that the residual claimant for the effort invested is the vendor itself. Hence:

Hypothesis 3b: The greater the explicit knowledge advantage of the vendor, the greater the likelihood of high-powered incentives.

3. Research Setting and Variable Descriptions

The measures developed in this study reflect discussions with practitioners and arguments emphasized in prior literature. First, we interviewed managers of outsourcing relationships and personnel in vendor

organizations with expertise in client relationships to gain an understanding of the IT outsourcing context and the nature of IT services contracts. Next, prior literature on IT contracting and managerial control were used to interpret contract structures for IT services (e.g., Whang 1992, Anderson and Dekker 2005). For instance, Whang (1992) suggests that IT contracts contain three essential elements — product definition (for e.g., design specifications, deliverables, and delivery terms), intellectual property protection criteria (for e.g. ownership of assets, titles, patents and rights) and payment terms (for e.g. payment schedule). Our data consist of contract documents obtained from the database of contracts maintained by the Contracting and Organization Research Institute (CORI) at the University of Missouri. Details in contracts in this collection were supplemented with contractual details made available in public disclosure filings (filed with the U.S. Securities and Exchange Commission's -SEC's) EDGAR Database. Contracts in our sample were written during the period from 1994 to 2006. From the original total of 188 Information Technology/Systems contracts in the SIC category 73, which denotes Business Services, filtering based on certain strict criteria resulted in a final set of 100 contracts.

First, we considered only transactions governed by laws in states within the United States of America. Second, we only selected agreements that included explicit task descriptions. Third, our set of contracts did not include any strategic alliances, joint ventures, mergers or acquisition transactions. Fourth, we selected only those contracts that involved only two business units (firms). Finally, the identity of the firm and the vendor had to be specified for all contracts in our dataset. When any of these conditions were not satisfied, the misfit contracts were eliminated from the sample (list-wise deletion). Each contract was examined and coded in great detail by at least two well-informed coders and required about seven hours per contract on average. The lowest inter-rater correlation between the coded values for the variables in our models was 0.98. Disagreements were resolved through repeated examination of the primary-referenced prior literature and strict adherence to the definition from prior literature. Firm and vendor information for each contract were matched with data from the One Source Online Business Information database and Hoovers database. The value of the contract was extracted from contract

documents when available. This data was supplemented with data from Factiva and ABI/INFORM Trade and Industry databases.

3.1. Dependent Variables

We relied on existing research whenever possible to guide us in the coding of measures where there was limited prior empirical work. The key dependent variables of interest in our study are — (i) the formalization of ex-ante *coordination mechanisms* in the contract, (ii) the strength of *intellectual property (IP) restrictions* specified in the contract, and (iii) *the extent of incentives provided to the vendor* by the client firm. The procedure for coding these variables is as follows.

For the *coordination mechanisms* measure, we examined the contract for the presence or absence of clauses that specified the ex-ante coordination processes for the duration of the contract mutually agreed upon by the transacting parties. The anchors for the measure were as follows: 0- No clauses indicating the presence of *joint management* arrangements for coordination, or explicitly appointed *steering committees* to oversee the progress of the project (Willcocks and Feeny 2006); 1 - Presence of one of the above clauses; 2 – Presence of both the clauses. Second, for the *IP restrictions* measure, we employed a four-point scale using the following definition of anchors. 0- No clauses indicating the presence of owner or jointly-specified intellectual property *ownership restrictions* on contracted products or services, or clauses requiring *non-disclosure* from the other transacting party, or indication of *product-usage* or product rights restrictions; 1 - Presence of one of the above clauses; 2 – Presence of two of the three clauses; 3 – Presence of all the three clauses. Sample clauses from our sample of contracts indicating these provisions are shown in Table 1. Third, for the *extent of incentives* measure, we coded the compensation (incentive) mechanism used by the client firm to pay for the IT outsourcing services using a three-point scale. This variable was extracted from the actual contract documents. We coded the measure on an ordinal scale with three levels: High-powered incentive contracts - fixed price (lump sum or fixed schedule payments), Medium-powered incentive contracts - hybrid pricing scheme (fixed price with incentive contracts and capped time and materials contracts) and Low-powered incentive contracts - time and materials contracts (payment based on periodic reports of vendor effort). We coded the two hybrid

schemes individually and finally pooled them into one variable consistent with prior work (Banerjee and Duflo 2000)².

<Insert Table 1 about here>

3.2. Independent Variables

Knowledge-intensiveness: Given the importance of capturing the extent of knowledge intensiveness of the *task* in a partner independent manner, we attempted to operationalize this measure entirely from the service description portion of the contract. Based on the services described in the contract, we first coded 5 different task specific measures. In the next step, we derived an aggregate measure on a six-point scale based on the levels of the 5 dichotomous variables. The dichotomous measures were coded based on the inclusion (or absence) of the following tasks within an agreement - System planning efforts, systems analyses and design activity, application development activity, advanced technical support, and presence of technical specifications. The overall measure was derived from aggregating these dichotomous variables. In the context of IT services, each of these five tasks indicates a potential exchange of both codified and tacit knowledge between the transacting parties. Systems planning, design and implementation efforts are known to need considerable effort in understanding the business domain of the customer and the functionality of existing IT systems, as well as dedicated intellectual and personnel resources to comprehend and adhere to critical technical architectures (Boehm 1981, Jones 2000). Hence, we consider the inclusiveness of above activities in the contract as an indication of knowledge-intensiveness.

Knowledge Advantage: We constructed two measures of knowledge advantage – *explicit* advantage and *tacit* knowledge advantage based on a two-stage process. In the first step, indicator variables for explicit and tacit knowledge were created for the vendor and the client firm using the following procedure and then created measures for knowledge advantage.

² We performed our analyses using dependent variables both coding schemes and apart from the loss of degrees of freedom and limited sample size for one of the hybrid categories, the overall directions of the coefficients did not change. Chow test for pooling did not reject the hypothesis that samples in these two groups were homogenous.

Explicit knowledge indicators: This dichotomous measure was coded as 1 (indicating ownership of task related knowledge by the client/vendor firm) if we could locate clauses in the contracts that explicitly indicated that the contracted service required knowledge in the form of design documents, blueprints, or patent information related to the contracted artifact(s) that were deemed to be owned by or solely licensed to the particular transacting firm. For instance, one contract in our sample included the following — *ABC (client firm) shall provide to XYZ (vendor) the equipment, design documents and architectural documentation as set forth in Exhibit A towards fulfillment of the (vendor's) obligations as per this agreement.* In this case, we coded the tacit knowledge variable for the client as 1. Similarly, we coded vendor explicit knowledge as high if we observed clauses where vendors owned prior knowledge. For example, one contract in our sample included the following clause — *XYZ performed ... (on a prior date) ...certain design tasks and pilots specified in Section A. The vendor agrees to provide documentation related to these tasks to ABC (client firm) during the performance of services specified in this agreement.* These variables were coded as 0 if there were no clauses in the contracts indicating that the client firm or the vendor firm had pre-existing ownership (prior to the contract date) of such codified knowledge required for the outsourced task such as design documents, patents or license rights³.

Tacit knowledge indicators: Tacit knowledge (know-how) involves useful knowledge that is inherently difficult to codify (Nelson and Winter 1982) and often indicated by aspects that are difficult to quantify, as in accumulated skill or expertise (von Hippel 1994). We inferred that a vendor had tacit knowledge required for the outsourced process if we observed indications of vendor having prior understanding of the client firm's processes, systems and the organizational context. For instance, one contract in our sample contained a clause such as follows — *(Excerpt)... The services are in connection with modification of software for [client firm]'s data processing systems and subsystems for its various business units requiring the professional and technical expertise of vendor to assist in these information systems initiatives. The vendor has been associated with this [client firm] formerly in a similar capacity*⁴.

³ Our measures of knowledge are consistent with knowledge stocks rather than flows (Dierick and Cool 1989).

⁴ This implies that vendor has knowledge about the technology, systems, people, and processes in the client firm.

Likewise, we inferred that a client firm had tacit knowledge about the execution of internal processes with information systems when we observed similar clauses implying ownership of prior knowledge by the client firm. For example, one contract included this clause — *ABC (client firm) shall, pursuant to Section A, provide vendor with access to personnel and pre-existing solutions as reasonably required by XYZ (vendor) for the performance of the services. The following [client firm] personnel ... will be available for the vendor ... [durations, obligations]*. We coded these dichotomous variables as 1 if we observed any of the following in the contractual agreement - (1) that the client firm has access to or the vendor owned *prior generation products or provided similar services* in the past to other firms. This interpretation is consistent with ‘accumulated skill/expertise’ view of know-how by von Hippel (1994) (2) descriptions in the contract of *persons or business units* related to the client firm or vendor who had prior expertise in the contracted task(s) consistent with the “location of expertise” notion noted by Dyer and Singh (1998) (3) that either party possesses *expertise in marketing of similar products/services* (Dhanaraj, Lyles, Steensma, and Tihanyi, 2004) or (4) contract explicitly indicated past or current reciprocal exchanges between the current parties or prior partners of either firm over tasks similar to the current agreement (e.g. Gulati 1995)⁵.

Explicit and Tacit Knowledge Advantage: Using the above indicators, we composed two ordered measures to capture knowledge advantage as follows. We created an *explicit* knowledge advantage measure that takes the value 0 when the client firm possesses explicit knowledge but the vendor does not. The measure takes a value of 1 when neither possess prior explicit knowledge. This variable takes the value as 2 if both the parties possessed explicit knowledge⁶. Finally, we coded the value of the measure as 3 if the vendor possessed such knowledge but the client did not. Using a similar process, we created a *tacit* knowledge advantage measure indicating the extent to which the vendor possessed such advantages.

⁵ Our measures of tacit knowledge are consistent with organizational tacit knowledge interpretation of Leiponen (2006)

⁶ Since the magnitude of the contribution of each party is difficult to ascertain from ex-ante designed contract, we do not rate the contributions.

We believe that capturing a one-sided (vendor advantage in this case) advantage measure would capture the asymmetric nature of knowledge disparity succinctly.

The central arguments in this paper rely upon distinguishing between different forms of knowledge relevant to the context of technology sourcing. First, as noted earlier, we consider the extent to which a task requires exchange of codified and tacit knowledge (independent of who owns what form of knowledge prior to the agreement). This construct is captured by the knowledge intensiveness measure, which is a task-based measure. Next, we examine the pre-existing explicit knowledge advantage that the vendor possesses from patented and codified knowledge stock from prior engagements. Third, we capture the pre-existing tacit knowledge advantage acquired from execution of similar services and prior experiences similar to the contracted task. For illustration, consider a financial services firm that outsources development of an information system to integrate customer information from different functional units such as consumer credit services and consumer mortgage banking. Such a system can improve the effectiveness of customer-interfacing interactions and thus is a competence-enhancing technological innovation (e.g., Tushman and Anderson 1986). Developing such an information system requires non-partner specific knowledge about customer facing processes (that we capture in the knowledge intensiveness measure). The client firm is likely to possess knowledge from prior experiences, such as prior initiatives to improve customer service with IT. Finally, if the same vendor developing the information system had collaborated with the financial services firm earlier in a related capacity, or on similar solutions development efforts with other firms, it is likely that the stock of pre-existing tacit knowledge (domain knowledge) as well as knowledge of prior solutions relevant to the contracted task is high for the vendor (a case where both parties possess prior tacit knowledge). All these forms of knowledge are captured in our measures of knowledge intensiveness (task-specific measure) and knowledge advantage measures (partner-specific).

3.3. Control variables

We control for several additional factors that are likely to be associated with coordination mechanisms, IP restrictions, and incentives. First, we control for the financial value of agreement (logarithm of the value

of the contract) since it could be argued that larger valued transactions are more likely to be collaborative in nature and might systematically be associated with explicit coordination mechanisms and lower powered incentives due to the likelihood of non-measurable outcomes that accompany expensive outsourcing agreements. Second, we control for the duration of the contract, which is an important contract design element (e.g., Joskow 1987) that reflects the intentions of transacting firms to pursue longer-term relationships, which would be reflected in the nature of the coordination mechanisms, IP restrictions and incentives. Next, firm size and vendor size (log transformed) were included as controls. A larger firm (e.g., vendor) can absorb greater overruns, and may be preferred to execute certain types of contracts. Similarly, large firms with considerable market power are likely to have a bearing on the initial contract parameters. The size of the firm could also act as a proxy for the bargaining power of the firm. Furthermore, it could be maintained that larger firms might employ *boilerplate* contracts with standard templates for their contracts. However, we find that in spite of certain amounts of redundant details in contracts from one firm, the contracts exhibit considerable variance in the dimensions of interest (e.g., codified knowledge, knowledge-intensiveness of the task, task descriptions). Both firm size and vendor size were measured in terms of the number of employees (e.g., Zenger 1994). In addition to these controls that apply to all the three models, we account for specific controls for the three models as we discuss next.

Industry similarity of the transacting parties is likely to play a role in coordination processes. For instance, partners in dissimilar industries might benefit from coordination mechanisms to enable knowledge transfer while competitive interests might play a role when partners are relatively similar. Lane and Lubatkin (1998) maintain that firms with similar organizational routines and structures are likely to generate greater learning returns from inter-organizational knowledge exchanges. To account for this argument and for identification purposes, we control for the industry similarity of the two transacting firms in the dyad in the coordination mechanisms model. For this measure, we create a dichotomous categorical measure that has a value of 1 when the first three-digits of the client firm's and vendor's SIC codes match.

We expect that certain agreements where explicit competitive information is being transferred from one party to another are more likely to be governed using strict IP restrictions over the competitive knowledge being transferred. Hence, we control for the nature of the agreement in the IP restrictions model by explicitly accounting for whether any form of technology licensing is included as part of the agreement such as computer software of either party is involved. This inclusion is especially important in a context such as IT outsourcing since ‘potentially weaker property rights might lead firms to structure contracts to circumscribe potential imitation’ (Anand and Khanna 2000b, p131) and hence firms might exert additional effort in designing restrictions in such agreements.

Related to opportunistic behavior are concerns of shirking and potential for suboptimal performance in contracts involving low powered incentives and firms are likely to build certain safeguards against such potential hazards. Hence, we control for the following two rights in the incentives model – (1) “termination for convenience” rights of the client firm and (2) rights of the client firm to audit outcomes of the outsourcing agreement. The presence of a “termination for convenience” clause in the contract often allows the client firm (and sometimes the vendor firm) to terminate the agreement prematurely without cause in case certain important factors do not confirm to the expectations of one firm or if one party exhibits opportunistic behavior. In our case, if we could locate explicit clauses that provided such an option for the client firm (e.g. Gurbaxani 2005), we coded this categorical variable as high (value = 1). For instance, one contract had this clause — *ABC (client firm) may terminate this agreement for its convenience at any time prior to ABC’s final acceptance of the products specified in Exhibit A for any reason or for no reason by giving the other party sixty days (60) prior written notice of termination.* Such provisions are less useful in high-powered incentive agreements where it is in the vendor’s best interest to exert effort. This logic is consistent with prior literature in agency theory that suggests that the prevalence of such provisions might reduce the risk of moral hazard (e.g. Brickley 1999). The descriptive statistics and pair-wise correlations for the variables in our models are presented in Table 2.

<Insert Table 2 about here>

4. Results and Discussion

We use multivariate regressions to test our relationships of our interest and the drivers of coordination mechanisms, intellectual property restrictions, and intensity of incentives. First, since the dependent variables are on an ordered scale, we also estimated the coefficients using independent ordered logit regression models treating the three equations as independent. Next, to account for potential interdependence among the three equations, we also carry out seemingly unrelated regression (SUR) estimation to test the explanatory effects on boundary spanning routines and IP protection arrangements. The SUR estimation allows us to impose less stringent identifying assumptions when some of the explanatory variables affect both the choices but some others affect only one of the choices (Zellner 1962).

We employ a logarithmic transformation for control variables such as contractual duration, monetary contract value, firm size, and vendor size (e.g., Zenger 1994). Further, in ordered models, since it is important to test whether the assumption of proportionality of odds across the levels of the dependent variable holds, we performed a Likelihood ratio test, and we could not reject the null hypotheses of proportionality of odds. All the three models exhibited statistical significance at $p < 0.001$. The maximum values of diagnostic statistics for influential observations (maximum *dfbeta* fit statistic of 0.5) and outliers (maximum Cook's distance of 0.6) suggest that influential observations and outliers do not significantly bias our parameter estimates (Belsley, Kuh and Welsch 1980). We present empirical results from the coordination mechanisms, IP restrictions, and incentives models in Table 3.

<Insert Table 3 about here>

4.1. Coordination Mechanisms

Knowledge intensive exchanges require search over a large solution space. This search process is iterative in nature requiring extensive interactions between client and vendor. Our results indicate that the knowledge-intensiveness of the task is strongly associated with the ex-ante specification of coordination mechanisms (indicative of the support for H1a) as shown in Figure 2. In other words, inter-firm coordination becomes necessary with certain features of the task (irrespective of partner capabilities).

Coordination mechanisms, in other words, are likely to enable firms achieve heuristic search. Firms are likely to exert effort in the contract planning process to specify clearly the coordination roles of the key members that would play a vital role in fulfillment of the contract objectives. Moreover, the increased uncertainty in the verifiability of outcomes associated with increased knowledge intensiveness encourages such specification of personnel roles and responsibilities ex ante. While such mechanisms enable collaboration during the exchange of domain and solution knowledge, they also provide an opportunity for either of the transacting parties to guard against opportunistic behavior from the other without relying on formal enforcement of obligations through courts, which might increase friction during a non-delegated exchange. Further, coordination mechanisms might reduce the reliance of client firms on output measurement, which could be particularly daunting for knowledge intensive tasks.

<Insert Figure 2 about here>

Inter-organizational problem solving arrangements enable a firm to gain access to key knowledge capabilities of the vendor without ownership of these resources (e.g., Mowery, Oxley and Silverman, 1996). Kale et al. (2000) posit that the most common form of inter-organizational learning is that of internalization of partner knowledge. Our findings reveal that when the vendor possesses a priori advantage in tacit knowledge, client firms are likely to craft ex ante coordination mechanisms to enable smooth exchange of knowledge (support for hypothesis 1b). Such coordination mechanisms encourage the vendor to invest in learning about the domain knowledge of the client firm and recombine it with the tacit solution knowledge that is pre-existing in the vendor organization. Since coordination mechanisms such as steering committees and joint management agreements make the organizational boundary permeable for tacit knowledge transfer, the two transacting organizations would better be able to set up joint problem solving capabilities, conduct heuristic search, and develop rich partner specific experience (e.g., Zollo et. al., 2002). Similarly, Mayer and Argyres (2004) maintain that inter-organizational learning takes place through an iterative and incremental process whereby parties accumulate a shared repository of knowledge. Recombination of knowledge from the vendor and the client is facilitated by extensive interactions between the client and the vendor, which enable the client to locate the critical expertise. In

the process of recombination, firms learn to manage the collaboration process and work better with each other (e.g., Doz 1996), which needs understanding of partner goals and redefining of joint tasks over time.

4.2. Intellectual Property Restrictions

Due to the crucial competitive role of knowledge developed over the course of the transaction, firms are concerned with ex-ante specification of ownership rights to the intellectual property created over the duration of the agreement. Certain characteristics of knowledge exchange increase the rent-seeking ability of the vendor. If knowledge gained through an exchange can be codified in some form, it becomes possible for clients and other firms to appropriate their knowledge. Given the specialized nature of knowledge and the fact that the vendor's investments in capabilities and processes confer a knowledge advantage, the vendor would want to protect this gained knowledge against leakage or appropriation from other firms, including the client. In contrast, we expect that if the primary knowledge during the course of the exchange is of a tacit nature, it is difficult to prevent appropriation. Our result (Figure 2) shows that contracts for knowledge intensive tasks are associated with stronger intellectual property restrictions (support for hypothesis 2a).

Contractual restrictions confer residual rights of control to the vendor, enhancing the incentives for non-contractible investments in learning about the problem. This is similar to arguments from Aghion and Tirole (1994) who state that the party whose investment has the greater marginal return should be granted the control rights. When vendor has a knowledge advantage, the vendor also needs to protect the stock of knowledge resulting from earlier investments or learned through prior exchanges, which is further enhanced through internal routines and capabilities. Our analysis indicates a prevalence of asymmetric protection mechanisms where the vendor firms are more restrictive in granting IP rights when vendors possess advantage in explicit knowledge. This finding could be due to the fact that codified knowledge is a more readily deployable (compared to tacit knowledge) source of significant competitive advantage for the vendor. As one of the purposes of the outsourcing arrangement is to provide the client firm with access to knowledge resources that are not present in the organization, the vendor may be

concerned about leakage of such proprietary knowledge as it could impact competitive success. Protecting such competitive knowledge advantage requires strong contractual safeguards against misappropriation.

4.3. Explicit Incentives

If the onus of learning is primarily on the vendor, this could potentially exacerbate the agency problem, suggesting that the role of incentive alignment is very crucial. When contracting for knowledge intensive tasks that require iterative search for solutions, specifying key outcomes and performance standards becomes difficult. Thus, as noted earlier, when precision of measuring outcomes is low, low powered incentives are required (Holmstrom and Milgrom 1994, Milgrom and Roberts 1992). In other words, the difficulty in verifying the effectiveness of knowledge recombination (e.g., von Hippel 1994) reduces the desirability of high-powered incentives. Our results indicate support for hypothesis 3a (Figure 2), that contracts involving knowledge intensive tasks are more likely to contain low powered incentives.

When the vendor has a knowledge advantage, providing high-powered incentives might actually distort incentives for effective knowledge creation and lead to vendor allocating greater effort on easily verifiable dimensions such as completion time and defect rates. An increase in tacitness of the task raises the risk of non-verifiability while codifiability of knowledge increases the ability of the client firm to observe effort, if not the outcomes themselves. Our findings point to the prevalence of high powered incentive contracts when vendor possess an advantage in explicit knowledge, thus supporting hypothesis 3b. In other words, when a vendor specializing in providing dedicated IT services (e.g., IBM, HP) is the residual claimant of knowledge gains, fixed price contracts will be optimal.

4.4. Controls

We find that large-valued contracts and contracts where the transacting firms are similar (in terms of the products and services they provide) are likely to be associated with fewer ex-ante coordination mechanisms. Our results indicate that longer-term agreements tend to involve stronger IP restrictions and are likely to involve low powered incentives. Large client firms tend to prefer high-powered incentive contracts. Further, the ownership of “termination for convenience” rights by the client firm and ownership

of rights by the client firm to audit outcomes of the outsourcing agreement are both associated with low powered incentive contracts.

<Insert Figure 2 about here>

4.5. Relative Importance of Contract Design Choices

We examined the standardized coefficients of the key independent variables from the SUR estimation models. We find that the most important variable associated with coordination mechanisms was the possession of the tacit knowledge advantage by the vendor. The next variable of importance was knowledge intensiveness of the underlying task(s). On similar lines, the most important independent variable associated with IP restrictions was the explicit knowledge advantage, followed by tacit knowledge (which was in the opposite direction of the explicit advantage coefficient). Finally, the most important variables influencing the extent of incentives were explicit knowledge advantage and knowledge intensiveness respectively.

Conversely, we find that, an increase in knowledge intensiveness as well as presence of tacit knowledge advantage with the vendor is most strongly associated (Figure 2) with prevalence of coordination mechanisms (among the three dimensions). Finally, ex-ante explicit knowledge advantages are mainly associated with strict intellectual property restrictions. These observations underscore the importance of understanding the (knowledge-intensiveness) nature of the underlying task as well as the ex-ante tacit and explicit knowledge advantages of the transacting parties, while structuring the contracts. While assessing these task specific and partner specific knowledge components might be a non trivial undertaking, they nevertheless provide a starting point for contract design to enable smooth knowledge exchange and recombination, and to simultaneously limit opportunistic behavior from the sourcing partner.

4.6. Limitations

Since we rely on cross-sectional and historical data, our study has certain limitations. We do not account for factors such as vendor selection and determinants of tacit and codified knowledge. Further, values assigned to some independent variables in our model such as tacit and codified knowledge are likely to change over time, and such transformations that occur over time with knowledge assets would need to be

captured through a longitudinal model. However, since we are primarily interested in ex-ante specified contract design and inter-organizational coordination and protection mechanisms, and are not examining outcomes of such transactions, this should not limit the generalizability of our findings. Finally, we treat variables such as presence of tacit and codified knowledge as dichotomous, when in the real world these might be multi-dimensional.

5. Implications for Theory

Prior research in economics has primarily examined knowledge exchange either through the lens of transaction cost economics that might suggest that the problems in transferring tacit knowledge might be better managed through vertical integration. However, these frameworks do not address the fact that outsourcing arrangements provide access to resources not available within the firm (Jacobides and Winter 2005). Further, while TCE is relatively more suitable for examining discrete transactions such as those that involve ‘one shot’ decisions (e.g., contract duration in the presence of asset-specific investments such as mine-mouth plants in Joskow (1987)), settings such as complex IT services agreements which involve repeated bilateral exchange, inter-dependencies between the firms’ knowledge-bases might benefit from an integrated viewpoint which simultaneously incorporates knowledge based insights and the role of opportunism.

As noted by prior literature on R&D and innovations, problem solving requires search or “local” knowledge of the problem space (von Hippel 1994). The process of knowledge acquisition and exchange across organizational boundaries involves friction (e.g., Argote 1999, Hamel 1991), such as weakened trust between partners due to differences in their learning abilities that can make them defensive about sharing knowledge (Hamel 1991). Economics literature (outside TCE) suggests that such friction can be managed through property rights or through incentives. A property rights viewpoint would suggest that the transfer of property rights to the party that makes specific investment in non-contractible actions (e.g., Aghion and Tirole 1994) might alleviate the friction. An incentive alignment perspective centers on the measurability of outcomes and monitorability of exerted effort. However, neither of these approaches explicitly addresses contexts that involve (a) tacit knowledge, (b) iterative problem solving, and (c) joint

learning processes and bilateral exchanges, all of which are highly relevant to knowledge-intensive exchanges.

Indeed, the challenge of replicating market-based efficiencies while also preserving features of hierarchy led scholars to caution against 'selective intervention' (Foss 2003, Williamson 1996). This paper therefore seeks to develop an alternative perspective. As exchanges involving knowledge become more pervasive, the design and effective governance of such arrangements is crucial to firms that seek to benefit from access to external sources of knowledge. Infusing market-based sourcing arrangements with features of hierarchy may be imperative given the difficulty in recombining the domain knowledge of the client with the solution knowledge of the vendor, and the difficulty for the vendor in learning about the organizational context. Features of hierarchy such as coordination mechanisms (e.g., overlapping teams, joint management agreements) have been proposed in prior knowledge-based research despite their limited direct role in addressing opportunism.

Recognizing that there is a tension between providing incentives for knowledge intensive tasks, enabling learning through explicit coordination mechanisms, and protecting knowledge assets through IP protection restrictions, we integrate explanations from incomplete contracting literature and the knowledge-based view of the firm to build a theoretical perspective of incentives from a perspective based on knowledge. This paper focuses on the challenge of creating formal mechanisms, through the design of the contract, that achieve these multiple objectives. This study's examination of knowledge intensive exchanges in an innovative context, that of IT outsourcing, presents a contrast to literature that has focused on exchanges that do not involve substantial recombination or knowledge exchange (e.g., Tanriverdi, Konana and Ge 2007). We observe that contracts for knowledge intensive exchanges have some elements of hierarchy as well as elements of market based arrangements. When tasks depend on 'sticky' local knowledge that is difficult to codify (consistent with the characterization of von Hippel 1994), we find that formalized inter-firm coordination processes can lessen the difficulty in transfer of such knowledge. Ex-ante specification of coordination mechanisms might also mitigate risks of shirking and opportunistic behavior by transacting parties.

Another contribution of this paper is to highlight the role of contractual restrictions, such as property rights, restraints on outside activities and non-disclosure agreements, to protect against knowledge appropriation when there is asymmetric information. We find that an increase in knowledge-intensiveness of the task is associated with restrictions on the critical knowledge assets involved in the knowledge exchange (consistent with Liebeskind 1996). Further, when the vendor owns the rights to the task-related intellectual property, we find greater IP protection mechanisms imposed on the client firm, possibly due to the potential re-deployment gains for the vendor.

Brusoni, Prencipe and Pavitt (2001) maintain that firms possess knowledge in excess of what they make and provide evidence from the telecommunications industry that firms continue outsourcing even when they retain in-house knowledge capabilities. Our results suggest that there could be a difference in the type of knowledge that exists in-house and that which is accessed through outsourcing. When outsourcing an information system, firms are likely to retain substantial domain knowledge that reflects – (a) the importance of the information system to the organization (b) the manner in which external entities such as suppliers and customers interact with the information system and (c) the inter-linkages between the information system and organizational design. However, this knowledge is different from the knowledge that is developed when firms build the information system in-house, which results not only in technological capabilities but also in knowledge about problem solving, akin to learning by doing (e.g., Arrow 1967).

Prior research on IT sourcing has examined the complementarity in competences across the client and vendor (e.g., Levina and Ross 2003). However, the issues of knowledge transfer and recombination involve potentially complementary knowledge bases of the client and the vendor. A successful outsourcing arrangement requires tacit knowledge about the organization that may be embodied in firm specific routines. We suggest that the effectiveness of coordination mechanisms that permit vendors to learn about the domain of the outsourced task may be greatest when vendors possess a substantial stock of pre-existing knowledge from prior experiences (tacit knowledge).

5. Conclusions and Future Research

Since knowledge intensive agreements require parties to share knowledge and learn from each other extensively, and because investments in learning are often difficult to verify, there is a potential for opportunism and misappropriation of knowledge in the outsourcing of innovative services. This paper explores the nature of contract design to deal with knowledge exchange (of both tacit and explicit forms) and the ex-ante bargaining advantages of the parties due to prior knowledge, both of which influence contract design.

An outsourcing agreement involves recombination of dissimilar knowledge that is consistent with exploitation. Future research can further examine implications for contract design in settings which primarily involve *joint exploration* of new knowledge as opposed to initiatives that involve both exploration and exploitation of partner capabilities. Studies can also explore the role of inter-firm collaborations that generate new knowledge when both firms and vendors possess a stock of knowledge about both the domain as well as the solution. In such settings there could be a considerable need for bilateral knowledge transfer and opportunities for learning, which suggests that a further investigation into the role of coordination mechanisms in the sourcing of technologically innovative products is a fruitful area for future research.

It has been posited that the assimilation of external knowledge is important both for firms and for the growth in innovations in the entire economy. In inter-firm relationships, the development of mutual knowledge and inter-firm coordination means increase the value of the relationship and stem potential opportunism (Dyer and Singh 1998, Ring and Van de Ven 1994). Ultimately, firms and vendors could develop competence in such arrangements through an iterative process of learning (e.g., Levitt and March 1988) where skills and routines are perfected through repeated practice (e.g., Nelson and Winter 1982). Firms' capacity to learn from the dyadic interaction with their vendors might be a significant determinant of innovations and evolving contractual structures, which is another area for future research.

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Figure 1: Summary of Hypotheses

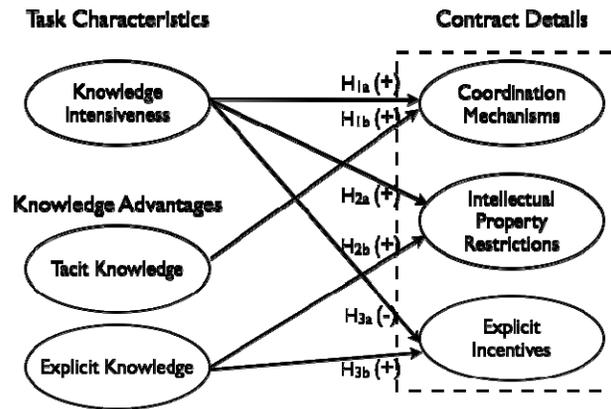


Figure 2: Relationship between task characteristics, IP restrictions and incentives

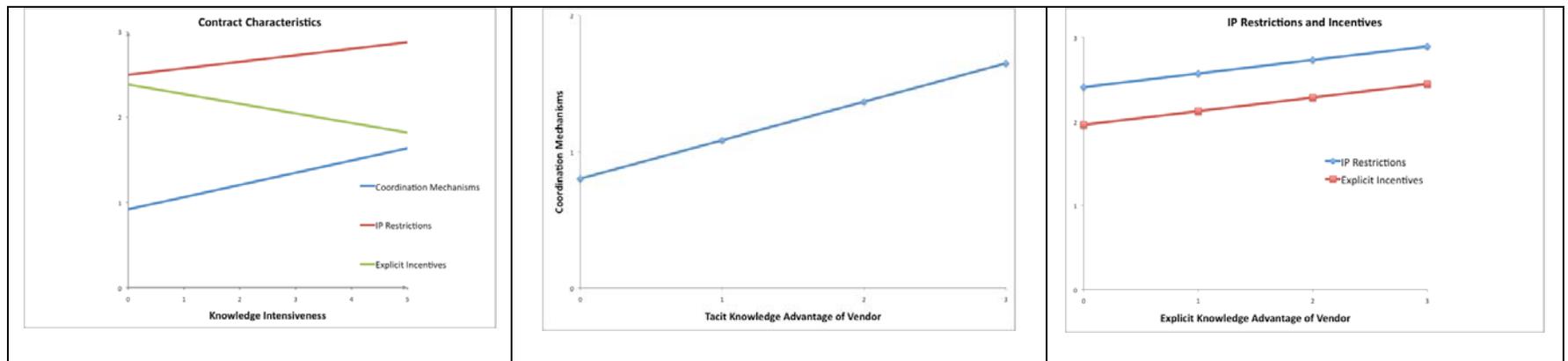


Table 1: A sample of contractual clauses for the dependent variables in our models

Variable	Coded Value	Sample Contractual Clauses (confidential elements omitted or masked)
Explicit Incentives	Low (Time & Materials contract = 1)	XYZ (vendor) shall invoice ABC (client firm) annually, not more than sixty (60) days prior to the commencement of the Initial Term ... and such invoice will be due upon receipt. These advanced support services are furnished on a "time and material" basis will be invoiced as rendered and shall be due thirty (30) days from the date of invoice.
Coordination mechanisms	Joint management = 1 (High)	2. Each party will designate up to three senior executives to participate in an Executive Steering Committee. The committee will be chaired by a representative of the (client firm) and will meet every period (month) to review the parties' performance under the Agreement and to provide general guidance with respect to the contractual obligations.
	Steering committee = 1	3. A change control committee will be created and chaired by the (client) firm's Program Manager and will meet at least once a week until the implementation of the initial requested systems, for the purposes of reviewing change requests. If the committee cannot agree on a change request in accordance with the pre-specified control process, then any party may submit the change request to the pre-specified dispute resolution process.
IP Protection restrictions	Property restrictions = 1 (vendor)	1. XYZ (vendor) agrees that all designs, plans, specifications, inventions, processes, and information produced by XYZ (vendor) concerning the design and development of T (technology) will be assigned to ABC (client firm) as exclusive property of ABC and its nominees and successors, as will any copyrights, patents or trademarks obtained by vendor while performing services under this agreement.
	Non-disclosure = 1 (Yes)	2. Each receiving party may disclose confidential information as noted in Exhibit A <i>only</i> to the other party to this agreement and its own officers, directors, and employees who <i>reasonably</i> (deemed by ...) need to know it. Each receiving party will be responsible to the disclosing party for any violation of this non-disclosure agreement.
	Product restrictions = 1	3. ABC (client firm) shall permit representatives of XYZ (vendor) to audit at all reasonable times any location where the T (tech) is being used (kept) by (client firm). The vendor agrees to notify client of any actual or suspected unauthorized use of the T (tech) and provide reasonable assistance to (client firm) in the investigation and prosecution of any such unauthorized use.

Table 2: Summary Statistics and Pearson Correlations (N = 100)

Variable	Mean	S.D.	Min	Max	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1) Coordination Mechanisms	1.17	0.74	0.00	2.00	1.00												
(2) IP protection restrictions	2.63	0.69	0.00	3.00	-0.09	1.00											
(3) Incentive mechanism	2.18	0.72	1.00	3.00	-0.10	-0.07	1.00										
(4) Knowledge intensiveness	1.77	1.31	0.00	5.00	0.42	0.06	-0.20	1.00									
(5) Vendor tacit knowledge advantage	1.52	1.13	0.00	3.00	0.43	-0.21	-0.02	0.39	1.00								
(6) Vendor explicit knowledge advantage	1.84	1.29	0.00	3.00	-0.05	0.32	0.05	-0.14	-0.32	1.00							
(7) Contract value (in millions)	13.30	2.69	0.003	146.00	0.16	0.14	-0.15	0.20	-0.08	0.21	1.00						
(8) Duration of the agreement (months)	40.05	30.88	3.00	100.00	-0.09	0.27	-0.18	-0.15	-0.17	0.20	0.13	1.00					
(9) Client firm size (in hundreds)	112.0	395.59	0.01	3325.5	-0.07	-0.04	0.01	0.10	0.10	0.14	-0.01	-0.10	1.00				
(10) Vendor size (in hundreds)	32.31	138.76	0.01	1170.0	0.09	0.06	-0.08	-0.14	0.08	-0.07	0.03	0.12	-0.03	1.00			
(11) Industry similarity of the firms	0.24	0.43	0.00	1.00	-0.19	0.03	-0.01	-0.12	-0.03	0.08	0.01	0.02	-0.10	-0.01	1.00		
(12) Tech licensing included	0.44	0.50	0.00	1.00	0.04	0.24	-0.03	0.47	0.02	0.18	0.16	0.06	0.16	-0.15	-0.12	1.00	
(13) Right to terminate relationship	0.36	0.48	0.00	1.00	0.11	0.10	-0.22	-0.04	0.03	0.07	0.24	-0.07	0.16	-0.06	0.02	-0.12	1.00
(14) Right to audit performance	0.63	0.49	0.00	1.00	0.09	0.28	-0.33	0.06	-0.22	0.27	0.25	0.20	0.06	0.07	-0.05	0.18	0.19

Table 3: Parameter estimates (N = 100)

Dependent Variables ->	Ordered Logit			SURE		
	Coordination Mechanisms	IP restrictions	Explicit Incentives	Coordination Mechanisms	IP restrictions	Explicit Incentives
Knowledge intensiveness	0.532 ***	0.364 *	- 0.387 **	0.143 ***	0.076 *	- 0.113 **
Vendor tacit knowledge advantage	1.679 ***	- 0.781	- 0.019	0.565 ***	- 0.197	0.003
Vendor explicit knowledge advantage	0.179	1.707 **	1.078 **	0.064	0.323 **	0.324 **
Contract value (log-transformed)	0.395 *	- 0.541	- 0.385	0.142 **	- 0.087	- 0.105
Duration of agreement (log-transformed)	0.162	0.584 **	- 0.744 ***	0.034	0.191 ***	- 0.219 ***
Client firm size (log-transformed)	- 0.049	- 0.068	0.185 **	- 0.022	- 0.002	0.039*
Vendor size (log-transformed)	0.037	0.085	- 0.007	0.009	0.021	0.000
Industry similarity of the firms	- 0.941 *	-	-	- 0.306 **	-	-
Tech licensing included	-	0.619	-	-	0.152	-
Right to terminate relationship	-	-	- 0.885 **	-	-	- 0.292 **
Right to audit performance	-	-	- 1.066 **	-	-	- 0.329 **
Model Fit	Pseudo-R ² = 0.18 $\chi^2(8) = 38.76$ ***	Pseudo-R ² = 0.17 $\chi^2(8) = 26.78$ ***	Pseudo-R ² = 0.17 $\chi^2(9) = 35.40$ ***	R ² = 0.33 $\chi^2(8) = 49.49$ ***	R ² = 0.23 $\chi^2(8) = 28.91$ ***	R ² = 0.29 $\chi^2(9) = 42.78$ ***

Note: *** $\Rightarrow p < 0.01$; ** $\Rightarrow p < 0.05$; * $\Rightarrow p < 0.10$