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# The Janus of Firm Design: The Impact of Information on Firm Boundaries and Structure

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This dissertation examines the forces that drive organizational structure and boundary decisions. Using theoretical concepts drawn from transaction cost theory and agency theory, this dissertation develops a model that draws attention to behavioral and outcome distinctions in information flow. Specifically it examines how characteristics of these different types of management information alter the organizational design outcomes predicted by the two theory bases above. The foundational arguments regarding firm boundaries and structure are based on the two contracting modes of agency theory, behavioral and outcome. The construct of information localization (IL), defined as the

need to use information within its immediate context (or conversely, the difficulty of transferring and utilizing information outside of its immediate context), is introduced and used to predict organizational design decisions. This construct represents a synthesis of prior conceptions of information characteristics and is used both to capture salient characteristics of management information and to facilitate an examination of the impacts of different information technology (IT) applications. The relationship between information localization and firm boundaries and structure is tested at the task level. The relationship of information technology with boundary and structure decisions is explained using the model and tested concurrently with the test of the information localization hypotheses. A comprehensive model is proposed and propositions to guide future research are developed. The distinction between outcome and behavioral information localization allows a more nuanced assessment of the impacts of information and information technology on the organization of work. The empirical results suggest that the impact of IT on outcome information localization is negligible for tasks with low outcome IL but increases the likelihood of outsourcing for tasks with high outcome IL. Contrary to prior findings utilizing different conceptualizations of information flow, the impact of technology on behavioral IL on autonomy showed that applications of IT may increase autonomy (decentralization of decision-making) rather than decrease it.

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# Chapter 1: Introduction

Why do we see the organizational forms that we see? Why are firm boundaries and firm structure organized as they are? Management scholars have put forward a variety of theories to explain the diversity of organizational designs observed in the economy. These theories have provided us with numerous interesting and useful perspectives from which to approach the issue. However, much of the prior discourse deals with the issue of organizational design by separating the matter into two separate and distinct questions: (i) the range of activities in which the firm will engage and (ii) the structure the firm will use to perform each activity. Theories about the range of activities a firm chooses to perform in-house instead of through outsourcing addresses the question of firm boundaries, whereas the choice between centralization and decentralization pertains to the question of firm structure. All functions (e.g., marketing, product design, manufacturing, after sale service) face these choices.

Few theories have explicitly dealt with firm boundary and firm structure decisions together. In addition, prior work has advanced diverse benefits associated with different organizational arrangements, making the study of organization form selection a very complex matter. The existence of two underlying dimensions of organizational design, centralization vs. decentralization and insourcing vs. outsourcing, is widely accepted (Milgrom and Roberts, 1992). The choice between centralization and decentralization has been argued as a response to many organizational needs. Some argue that centralization improves coordination and control (Kuhn and Beam, 1982; Harris and

Raviv, 2002). In contrast, decentralization improves responsiveness (Ansoff and Brandenburg, 1971; Bennis, 1966; Perrow, 1972) and alignment of incentives (Marschak, 1965, Spence and Zeckhauser, 1971). Outsourcing is often described as a means of allowing firms to focus on core competencies (Hillmer and Quinn, 1995; Milgrom and Roberts, 1992) and to leverage scale advantages through the use of focused suppliers (Milgrom and Roberts, 1992).

A number of recent studies have noted the rapid change in the configuration of industries and organizations (Afuah, 2003; Brews and Tucci, 2004; Sampler, 1998; Sampler and Short, 1998) and the proliferation of 'hybrid' forms that combine elements of designs formerly treated as separate and distinct choices (Child and McGrath, 2001; Fulk and DeSanctis, 1995; Jacobides and Billinger, 2006; Nault, 1997; Santos and Eisenhardt, 2005; Zenger and Hesterly, 1997). The significant role of information technology in many of these changes in organizational form has also received particular attention. Yet the effects of information technology, once considered by many to be deterministic (Huber, 1990; Malone, Yates, and Benjamin, 1987), have proven more difficult to corral (Robey and Boudreau, 1999).

Given the diversity of influences on the activities of a firm and the wide variety of approaches to structuring that activity, one mechanism for delving beneath the complexity is to assess such activities at a more atomistic level. This study attempts to begin such an effort. A theory of the organization of work is developed, leveraging prior literature on work organization with particular focus on transaction cost economics and agency theory. The theory development builds from these foundations. The two theory

bases have been applied in both macro- and micro-level analyses of activity and provide a solid foundation for the analysis herein.

Leveraging the seminal work of Gurbaxani and Whang (1991), this dissertation presents a model of the organization of work at a task level that is built upon a theoretical unification of sourcing arrangements and centralization-decentralization of decision authority. Whereas Gurbaxani and Whang examine questions of vertical and horizontal organization, including outsourcing-insourcing and decision authority and the effects of information technology on both, the analyses of these approaches are largely separate. Following the logic of arguments from shared services research (Bergeron, 2003), the model presented herein attempts to clarify a unified view of vertical organization (boundaries) and horizontal organization (structure) as two tightly interrelated elements of the organization of work. This conception of the relationship between the vertical and horizontal organization of work facilitates a model that provides additional clarity regarding the diverse impacts of information technology (IT) on work organization. Focusing on the impact of applications of technology on the particular tasks that underlie more macro-level phenomena, this dissertation gives a ground level view of the foundational concerns that underlie higher level firm design decisions.

Technology and technological change fundamentally impact organizational design choices by changing the nature of tasks, work processes, and the workplace (McKelvey, 1982; Tushman and Anderson, 1986). The increasing use of IT has amplified both the pace of change and the breadth of potential organizational design approaches, as IT influences the vertical and horizontal governance mechanisms that are

used by firms as they organize and manage the myriad tasks that they carry out by giving firms greater flexibility regarding how to organize different activities (Gurbaxani and Whang, 1991). Such flexibility is a critical enabler of the 'hybrid' forms noted above. A clearer understanding of this impact of IT is of particular importance as technology driven changes accelerate.

The difficulty in assessing the impact of information technology is in part a product of the fundamentally different nature of information when compared to other assets. Information has been recognized for its critical importance at least since the time of Coase (1937) and Hayek (1937, 1945). Though it is possible to consider information as an asset just like any other, one important feature of information is its importance in the employment of other assets. This feature is an important element in the literature on property rights (Grossman and Hart, 1986; Hart and Moore, 1990). Property rights will come up again later in the discussion of the interaction between information localization and physical asset specificity, the two dimensions of the expanded model presented. In the empirical component of this dissertation the role of information is central, but propositions regarding the importance of physical assets and the interaction of such physical asset specificity with information characteristics are also developed.

It is important to keep in mind the central importance of information in the organization of work. As Holmström and Roberts (1998) put it, "Information and knowledge are at the heart of organizational design" (p. 90). In fact, some authors have argued that knowledge is the primary reason for the existence of firms (Kogut and Zander, 1992). However, Foss (1997, p. 470) argues that "it is not possible to tell very

much of a story about why there should be firms in lieu of notions such as ‘opportunism’ or ‘moral hazard’.” As the arguments below contend, these different approaches are complementary rather than contradictory.

The notions of opportunism and moral hazard are central to transaction cost theory (Coase, 1937; Williamson, 1975) and agency theory (Eisenhardt, 1989; Grossman and Hart, 1986; Jensen and Meckling, 1976; Ross, 1973), the theory bases on which the present model of the organization of work is grounded. Mahoney (1992, p. 559) notes that “in the absence of agency and transaction costs, vertical financial ownership and vertical contracting are equivalent governance structures for achieving corporate objectives.” This observation implies that the central factors that determine organizational design are precisely such agency and transaction costs. The theoretical arguments regarding the concept of physical asset specificity from transaction cost theory and the information component of monitoring costs from agency theory are central elements in the model presented herein.

While transaction costs and agency theory have been used in research at the firm or industry level, they have also been applied at more micro levels of analysis. Such application recognizes the fact that broader organizational patterns subsume more atomized activities and tasks that are generally similar in some salient fashion. This dissertation approaches the relationship between firm organization and information at the task level, specifically engineering designs of components in manufacturing. Organizational decisions regarding boundaries and structures are central to the arguments regarding barriers to information flow.

*Information localization* constructs are introduced to capture this informational component. When information is localized it is more difficult to conduct monitoring and manage activities from a distance due to the difficulty of transferring necessary information about the local context. This construct synthesizes multiple elements of information transfer requirements, utilizing the distinction between outcome information and behavioral information from agency theory while also leveraging insights from research in the transaction cost stream. The distinctions regarding information localization are mirrored in constructs that capture specific applications of information technology in order to help clarify how IT may moderate the impact of information requirements on the organization of work.

Physical assets are also recognized as exerting significant influence on organizational choices. One effect of the specificity of physical assets is to exacerbate contracting problems because of the firm's inability to use those assets to generate similar revenues in any other application, reducing the firm's flexibility and leaving it open to the potential for holdup. The attractiveness of centralization or decentralization may also be affected by the ability or inability to use the same physical assets across multiple activities. The use of these two constructs, physical asset specificity and information localization, allows explanation of firm boundary and structure decisions with a unified, parsimonious model while also clarifying the impact of information technology through its effects on these two dimensions.

## *Contributions*

This dissertation extends current theories of organizational design and theories about the potential strategic impact of information systems on the organization of work. The information localization construct is developed to help clarify the important role that different types of knowledge and information flows play in determining organizational forms and relationships, specifically focusing on how tasks are organized and managed within and across firms. This construct synthesizes prior literature utilizing transaction cost logic as well as the concepts of behavioral and outcome contracting from agency theory, examining how these elements operate at the task level. The potential impact of information systems on such organizational decisions, particularly with respect to knowledge work, is also clarified via the information localization construct and measures of targeted applications of technology. Such clarification of the potential role of information systems in altering the tradeoffs implicit in firm design decisions regarding knowledge intensive tasks provides a new perspective on the strategic importance of information and information technology. In addition, a comprehensive model is developed describing the interactions between multiple forces that are theorized to impact firm design. This model provides testable propositions for future studies to tackle.

Information is necessary for managing relationships and conducting operations of any type. By clarifying the importance of this informational necessity vis-à-vis the predictions of agency theory, the information localization construct enhances our understanding of task-level work organization tradeoffs and presents opportunities for examination at other levels. This dissertation also provides value to the field through the

development and initial validation of a new instrument to test this aspect of information with respect to firm structure at the task level. The empirical test provides support for the use of an agency theory conceptualization of distinction between outcome and behavioral information flows at work in determining work organization at the level of individual tasks. As broader firm structures are composed of individual tasks it is likely that insights from this initial study can be leveraged in the examination of boundaries and structures at other levels of abstraction. This research also provides another connection between the logic of agency theory research and that of transaction cost theory by clarifying a mechanism through which different agency theoretic concerns may impact transaction costs.

This dissertation opens new avenues for research into the potential for information systems to have a strategic impact in organizations by clarifying the role of information systems in managing different types of information flows. This research provides more nuanced explanations of IT's potential to alter the impact of different types and levels of information localization. While the technology itself may be considered a commodity, information systems must still be applied appropriately in order to facilitate those information flows that are necessary to support whatever design is selected for organizing specific activities. Such appropriate application of information technologies is of considerable strategic import, and appropriate practices may vary considerably across contextual differences as evinced by the findings with respect to individual autonomy. Opportunities for future research will be enhanced as a result of the development of new operationalizations of constructs to help clarify the assessment of

such applications of technology. The development and initial validation of an instrument for measuring these information localization constructs at the task level of analysis provides a starting point for new avenues of research into the strategic potential of information technology and clarification of agency theory and transaction cost logic with respect to information.

The illumination of the salient distinctions between outcome and behavioral information that is enabled by the present operationalizations of information localization, coupled with the assessment of focused application of information technology to these particular types of information, yields interesting new insight into the effects of information flows and applications of information technology on the organization of work. The empirical results detailed below suggest that the impact of IT on outcome information localization is negligible for tasks with low outcome IL but increases the likelihood of outsourcing for tasks with high outcome IL. In addition, the impact of technology on behavioral IL on autonomy shows that applications of IT may increase autonomy (decentralization of decision-making) rather than decrease it, contrary to the findings of prior studies utilizing conceptualizations of information flow that do not draw clear distinctions between the two different types of information examined in this study, outcome and behavioral. Table 18 detailing the differences in predicted or observed effects of information on different organizational parameters is presented on page 170.

The more comprehensive theory provides a valuable extension of both agency theory and transaction cost theory. Propositions regarding physical asset specificity, information technology impact on physical asset specificity, and interactions between

physical asset specificity and information localization provide a launch pad for more detailed examination of the importance of information localization to firm design issues and the organization of work. The findings of this study suggest that further work to increase confidence in the present findings and to examine the broader propositions developed herein is warranted. Future research can build upon the theoretical arguments and propositions developed here, test the proposed integrated model of determinants of firm boundaries and structure, and provide a yet more enhanced understanding of the implications of information localization for the organization of tasks and business activities more broadly.

Finally, this dissertation provides several implications of potential interest to practitioners. It illuminates a new, constructive perspective on the informational requirements of different organizational choices. Such a perspective may provide new insights regarding the development and implementation of communications technologies. Improving our collective understanding of the impacts of information localization also has implications for innovation more broadly, particularly in contexts where highly local information is used or developed. Those involved in international business ventures may also find the concept of information localization of use. While the characteristics of the operational domain are important when considering specific information localization effects, cultural context may be of even greater importance in many situations. Indeed, concepts such as cultural distance may interact with the concepts regarding localization of information that this dissertation presents. Thus, by clarifying the nature of

information localization and its potential impact on the management of work, this research may enhance both practice and theory.

# Chapter 2: Literature Review

As noted above, management theorists have put forward a variety of theories to explain the diversity of organizational designs and sizes observed in the economy, but much of the prior discourse emerging from these theoretical approaches deals with the issue of organizational designs by separating the matter into two separate and distinct questions: (i) the range of activities the firm will engage in and (ii) the structure the firm will use to perform each activity. This bisection of firm design into (i) firm boundary decisions and (ii) firm structure decisions has proven very useful for clarifying the advantages and tradeoffs that different organizing choices entail. For example, in every function centralization has been associated with scale advantages and control (Ansoff and Brandenburg, 1971; Mahoney, 1992; Williamson, 1975), coordination (Kuhn and Beam, 1982), incentive alignment benefits (Marschak, 1965), and responsiveness (Ansoff and Brandenburg, 1971; Perrow, 1972), and outsourcing is seen as a means of focusing on core competencies (Hillmer and Quinn, 1995) and gaining flexibility (Milgrom and Roberts, 1990). Interdependencies and complementarities may complicate sourcing decisions, particularly where knowledge is of significant importance, sometimes leading to concurrent sourcing (Parmigiani, 2007; Parmigiani and Mitchell, 2009).

Increasing use of information technologies to enable new firm designs (Brews and Tucci, 2004; Jacobides and Ballinger, 2006; Nault, 1997) and new market structures (Child and McGrath, 2001; Malone, Yates, and Benjamin, 1987; Sampler, 1998; Sampler and Short, 1998) raises myriad questions regarding the impact of information and

information technology. Many industries are characterized by an increasing pace of change and continuous strengthening of competition where competitive advantages are ever more fleeting (Thomas, 1996). Technology fundamentally impacts organizational design choices by changing the nature of the task, work processes, and the workplace (McKelvey, 1982), and technological change can drive dramatic changes in organizational designs (Tushman and Anderson, 1986). While tradeoffs have always been a critical part of strategy, the increasing use of IT has amplified both the pace of change and the breadth of potential organizational design approaches, as IT influences firm boundaries and structure by giving firms greater flexibility regarding how to organize different activities (Gurbaxani and Whang, 1991).

While information technology plays a central role in enabling new organizational designs, it is far from the only factor that influences firm boundaries and structure. Managers and employees must consider myriad elements from the firm's environment and the firm's capabilities and weight the panoply of options available against the needs of the organization. Thus, management and employees choose and implement technology generally with an eye toward specific purposes to be accomplished. Technology may act as an influence on the range of options available, but the human beings within the firm select and direct technology in a goal-driven fashion. Therefore, while the model presented in this dissertation greatly simplifies the domain, interactions between technology as exogenous force acting on the firm by changing its environment and technology as endogenous creation and choice of management should be anticipated.

A great deal of research has examined the issue of firm organization. Within this broad domain of research, organizational economics has dominated research into boundary (insourcing versus outsourcing) and structure (centralization versus decentralization) questions. Given the purpose of this project to examine organization by integrating the boundary and structure questions often dealt with separately in prior research, the model is built with extensive reference to agency theory (Eisenhardt, 1989; Grossman and Hart, 1986; Jensen and Meckling, 1976; Ross, 1973) and transaction cost theory (Coase, 1937, Williamson, 1975). These widely explored streams of research represent the principal organizational economics paradigms for scholarly examinations of organizational design questions.

Since the current research attempts to combine two previously largely distinct bodies of research, the literature review will approach each of these domains somewhat separately. In some cases, prior theories have identified implications that cross these boundaries, so this approach may entail some repetition, though this should aid in developing clarity regarding the arguments that will be made later.

## *Boundaries – Vertical Organization of Work*

One of the central elements that this research will seek to explain is that of the import of boundaries in the organization of work – what is produced internally versus what is purchased externally through market transactions, the classic make or buy question. As noted above organizational economics approaches have been very important in the literatures examining questions of boundaries and structure in the

organization of work. This organizational economics literature is dominated by two primary branches, transaction cost theory and agency theory. Mahoney (1992, p. 559) notes that "in the absence of agency and transaction costs, vertical financial ownership and vertical contracting are equivalent governance structures for achieving corporate objectives." This implies that the central factors that determine organizational form are precisely such agency and transaction costs. This dissertation uses the respective literatures discussing such costs to ground the model of the determinants of boundaries and structure presented later in this paper.

## Transaction Cost Theory

Transaction cost economics (Coase, 1937) is among the most widely recognized and researched theoretical approaches in the literature on boundaries. Transaction cost theory describes structure as a reaction to the costs associated with using external markets as a mechanism of exchange. Transaction cost theory became a legitimate avenue for organizational research largely due to the work of Oscar Williamson (1975, 1981, 1982, 1985, 1996). Williamson built on the seminal work of Coase (1937), Hayek (1945), and Simon (1957) among others to build an operationalized view of transaction costs as a driver of choice in the organizational mechanisms used for different endeavors. The primary unit of analysis in Williamson's work is the transaction while the costs associated with a specific vertical organizational choice are divided into two basic types, production costs and transaction costs.

The transaction cost literature identifies two fundamentally different methods for organizing production: vertical integration on the one hand, and outsourcing or the use of

the market on the other. One primary argument favoring the use of markets is efficiency due to scale advantages. Since external markets serve larger pooled demand, specialists are able to focus on doing one thing, allowing them to do it more efficiently and effectively than any single customer can. However, transaction cost theory notes that there are costs to carrying out such transactions, particularly costs of coordinating with external suppliers. These coordination costs include the cost of selecting the supplier, specifying terms and conditions of the contract, monitoring performance with respect to the contract, and taking remedial action if necessary. If coordination costs are high, internal production becomes more desirable and vertical integration is a likely result.

Transaction costs arise in large part due to issues of bounded rationality (Simon, 1957). Bounded rationality is, at its core, focused on information/knowledge transfer and processing issues. According to theories of bounded rationality, both principals and agents are incapable of acquiring and using all potential information regarding the appropriateness of a given transaction. The need to gather and process information regarding the external provider and the transaction increases costs for the purchaser. The possibility of unforeseen production issues or transaction problems increases costs for the external provider, as does the transfer of risk inherent in most outsourcing.

Williamson (1973) proposed the concept of information impactedness as an attempt to capture the difficulty of accessing necessary information regarding such transactions, but this construct has led to limited empirical examination. The concept of information specificity (Choudhury and Sampler, 1997) has been used in the context of environmental scanning to assess the impact of information/knowledge disparities across

and within firms. Choudhury and Sampler use a number of terms in their discussion of the impact of knowledge and information, including knowledge specificity and time specificity, and further distinguish between specificity in acquisition and specificity in use. However, the primary theoretical thrust of the paper examines the cost of acquiring environmental information and the allocation of resources to scanning activities, with particular focus on the allocation of responsibilities. Though the paper focuses on developing theoretical implications for further study rather than empirical assessment, the examination indicates the salience of structure and boundary decisions regarding questions of information gathering.

While both the use of markets and the use of vertical integration involve contracting issues, the contracts inside an individual firm are typically incomplete contracts and substantial leeway in interpretation lies with the firm via the authority relationship (Simon, 1951). Diseconomies of scale may also arise in situations where coordination becomes more difficult as scale increases. Coordination costs are particularly high in situations where transactions between entities require specialized physical assets (Williamson, 1975), and such assets play an important role in the theory presented later in this paper. If there are no alternative uses for an asset involved in an exchange, or at least none with equivalent economic value, the possibility of hold-up increases. In hold-up situations one party has considerable advantage in future contracting due to the lack of alternative uses for an asset acquired by the other party. Contracting in such circumstances becomes much more difficult, reducing the efficiency gains of using the market and increasing the attractiveness of vertical integration.

Although transaction costs have been used in the examination of firm level and economy level phenomena, the insights available through the application of TCE need not be restricted to a single level of analysis. Williamson suggests use at more atomized levels of analysis when he characterizes transaction cost analysis as "an examination of the comparative costs of planning, adapting, and monitoring task completion under alternative governance structures" (1981, pp. 552-553). The importance of the same fundamental concerns of transaction cost theory in the analysis of firm-level and task-level phenomena was indicated earlier by Alchian and Demsetz (1972) in their argument that firms arise due to the technological nonseparability of tasks. This argument implicitly characterizes firms as collections of tasks.

Transaction cost approaches have been extensively used at more detailed levels of analysis. For example, transaction costs have been used in the examination of organizational choices in the automotive industry at the part level (Monteverde and Teece, 1982) and the component level (Walker and Weber, 1984; Walker and Weber, 1987; Masten et al., 1989). Sales force integration at the level of the sales manager rather than at the firm or division level has been examined using transaction cost analysis (Anderson and Schmittlein, 1984; Weiss and Anderson, 1992). Transaction costs economics has also been applied to the analysis of the component level contracting in naval ship building (Masten et al., 1991) and aerospace, electronics, and defense (Pilling et al., 1994). The Masten et al. 1991 study extended earlier transaction cost examinations to investigate the effects of internal organization costs, as well. The need for micro-level

data in order to construct valid empirical tests of transaction cost frameworks has also been pointed out (Rindfleisch and Heide, 1997).

While transaction cost analysis has proven fruitful in the examination of boundary and structure choices across multiple levels of analysis, other avenues of exploration have been utilized, as well. For example, it has been argued that firm boundaries and organizational capabilities co-evolve, and thus, that the concept of "determinants of boundaries" is incomplete due to the reciprocal nature of effects (e.g., Jacobides and Winter, 2005). Other recent studies have introduced real options theory in order to explain boundary decisions (Leiblein and Miller, 2003), particularly in situations where a single organization both makes *and* buys (Schilling and Steensma, 2002). Though real options may help explain some boundary decisions and certainly seems to be an attractive area for future research, alternative explanations based on more traditional decision criteria have arisen for such arrangements. Jacobides and Billinger (2006) examine the adoption of a permeable vertical architecture "to manage capacities and leverage differentiated capabilities along the value chain." They are essentially arguing that it is possible to leverage the advantages of both hierarchy *and* outsourcing by utilizing architectures in which activities lie within the firm but are also partly open to external markets. While new approaches to research into optimal boundary decisions certainly provide interesting new dimensions for research, the importance of asset specificity has been empirically validated in numerous studies covering a wide variety of contexts (for a review see Shelanski and Klein, 1995). Thus, in the model presented below and in the future research section, I focus on the impact of specialized physical assets in more detail.

Despite the power of transaction cost theory to explain many organizational outcomes, it does have some limitations. One of these limitations is precisely the breadth of outcomes purportedly explained by transaction cost theory. As Stanley Fischer put it, "there is a suspicion that almost anything can be rationalized by invoking suitably specified transaction costs" (1977, p. 322). This was, of course, prior to much of Oscar Williamson's work on operationalizing transaction costs for empirical work, but if transaction cost theory can "explain" everything, to a very real degree it really serves to explain nothing. Such criticisms open the door to other approaches to explaining boundary and structure arrangements.

## Agency Theory

Agency theory argues that boundaries are driven by contracting issues and the delineation of property rights (Jensen and Meckling, 1976). Agency problems arise when there is a lack of goal congruence such that an agent, who does not own the assets of production, may lack incentives to act in the interests of the principal, or owner. Eisenhardt (1989) describes this goal incongruence as partial since complete goal incongruence would preclude contracting of any kind. The primary unit of analysis in agency theory is the contract, which can generally be considered as roughly analogous to a transaction instance.

Goal divergence may be between the goals of the principal (owner) and the agent (employee) (Berle and Means, 1968; Demsetz, 1983), or it may be between different parties in a market transaction, where it underlies the transaction cost economics (TCE) concept of opportunism (Grossman and Hart, 1986). The focus on the contract as being

of central importance for dealing with such potential divergence is similar to the perspective of TCE. Arguments regarding contractibility from agency theory posit that when outcomes are difficult to measure or when the relationship between effort and outcome is unpredictable, internal hierarchy will be favored over outsourcing (Eisenhardt, 1989), due to the increased flexibility of governance through internal, behavioral contracting versus external, outcome contracting.

Agency costs are broken down into monitoring costs, bonding costs, and residual loss. Contracting is viewed as a control mechanism and the focus of organizational efforts is on determining the optimal contract (Eisenhardt, 1989). For those transactions where it is possible to detail specific responsibilities and dispositions of assets under all likely contingencies, the use of the market through outcome based contracting is generally considered preferable. Such outcome contracting enables specialization and the capture of value resulting from efficiency or increased productivity, often due to increased scale or focus. On the other hand, when uncertainty is high and the contingencies cannot be adequately determined, behavior based contracting using internal hierarchy is considered to be more effective.

One critical difference between these two forms of contracting that will play an important role later in this paper is the kind of information necessary for maintaining control. Outcome based contracting requires more limited monitoring information as it is driven by incentives based on achievement of desired, generally clearly specified outcomes. Behavior based contracting, on the other hand, requires detailed monitoring information on desired behaviors that may be less precisely specified/specifiable,

necessitating even greater breadth of monitoring information for maintaining effective control.

Though the tenets of agency theory have been widely accepted and used in myriad studies of work organization, one extension of agency theory challenges a basic assumption regarding monitoring costs. An examination of the professional services arena challenges the assumption of the ability of the principal effectively to monitor performance using *either* behavior *or* outcome measures (Sharma, 1997). Professional services typically involve severe information asymmetries between principal and agent; principles that contract with agents for professional services are seldom able to monitor behavior effectively. However, risk attitudes and difficulty in measuring outcomes in many situations makes outcome based contracting infeasible. Sharma introduces four new types of control to deal with such information asymmetry.

Similar to the uses of transaction cost analysis as noted above, agency theory has been applied across multiple levels of analysis. However, in the case of agency theory, the connection to individual level phenomena is perhaps more immediate than its uses at more expansive levels of abstraction. Rao and Nielsen (1992) indicate that agency theory is often associated with micro level analyses, arguing that "conjoining the agency and ecological perspectives focuses attention on the linkage between micro-level and macro-level selection processes" (p. 449). They further elaborate on the connection between an agency perspective and an ecological perspective, pointing out that agency theory involves micro-level selection processes. "When agency theory proposes-that the efficiency of monitoring and incentive alignment determines the survival of

organizations, it posits that the selection of organizations depends on the efficacy of micro-level selection processes within organizations, thus extending ecological models of organizations" (p. 467). More recently, Kim and Mahoney (2005), in a discussion of property rights theory, transaction costs theory, and agency theory as approaches to the study of strategic management, noted that "theories of institutional change at a macro-level can be applied to a more micro-level setting" (p. 225).

Empirical results have been consistent with the argument that outcome measurement difficulties lead to vertical integration (Anderson, 1985; Jones, 1987). While both of these studies use a transaction cost theory base, both are concerned with fundamental elements of the agency problem. They both show that when agency problems are significant, they often have an effect on organizational boundaries in the real world. Some more recent work has attempted to test transaction cost theory against agency theory in order to assess their relative explanatory power. For example, Kochhar (1996) found that transaction cost theory explained firm financial structure better than agency theory.

## Property Rights

Ownership is also a key aspect of agency theory and the related literature on property rights. Contracts maintain their central importance in this view, and the firm is argued to be primarily "a nexus of contracts" (Jensen and Meckling, 1976). Grossman and Hart (1986) point out the importance of two distinct types of contractual rights: specific rights and residual rights. Specific rights are those rights that are detailed in the contract, while residual rights are the rights to anything not covered in the contract

(essentially the rights of ownership). In situations wherein adequate delineation of specific rights is too difficult/costly or impossible, ownership of residual rights becomes important. Hart and Moore (1990) discuss the flexibility and investment implications of different ownership arrangements. Though some of the theoretical arguments in this work, which are necessary in order to complete the mathematical underpinning, are less than satisfying (e.g., stochastic control, cooperative bargaining[1]), the arguments do serve to provide some support for the assertion that property rights divisions (as often occur when activities are outsourced) can lead to underinvestment.

The importance of ownership has been reconfirmed in studies such as the Bakos and Nault (1997) analysis of electronic networks and Brynjolfsson's (1994) study of information assets. However, ownership alone does not resolve all investment incentive problems and many alternative arrangements have arisen (Holmström and Roberts, 1998). Holmström and Roberts point out that even slight changes in assumptions can invalidate the implications that many studies draw regarding the effects of ownership, and they argue that most of the conclusions reached are sensitive to the specific bargaining approach used. In addition, their paper details several arrangements (exclusive sourcing, inside contracting, alliances, networks, etc.) that seem to represent alternatives to direct ownership, often in response to issues other than the impact of ownership on investment incentives. However, they stress that ownership does present levers that affect incentives.

[1] This is not "cooperative bargaining" as in unions. Rather "cooperative" here indicates non-adversarial contract negotiations where both sides openly seek a jointly optimal outcome.

As with transaction cost theory, property rights theory is often used in the examination of firm-level phenomena. However, the examples used in the foundational literature of property rights theory often refer to micro-level elements. Such examples are often presented for expository simplicity, but they underscore the salience of many of the implications of property rights theory to micro-level phenomena. Indeed, as noted above, Kim and Mahoney's (2005) argument regarding the application of macro-level theories to micro-level settings included among its focal theory bases that regarding property rights. This wide acceptance of the link between micro-level phenomena and macro-level outcomes, including the application of the broad theory bases that form the foundation of the present research, lend support to an integrative approach examining such concerns at a micro-level, as well as to the advancement of more macro-level propositions for future research based on similar theoretical underpinnings.

## Information / Knowledge

Knowledge has also been identified as a critical element in boundary decisions. Several studies have pointed out the somewhat unique nature of information and knowledge and their importance as a different kind of asset (Brynjolfsson, et al., 1994; Sharma, 1997; Tanriverdi and Venkatraman, 2005). Information and knowledge are applied in the process of utilizing other assets. Every business use of an asset involves the concurrent use of the knowledge regarding how to employ that asset. In many industries, effective utilization of such knowledge is the key differentiating factor between success and failure. Those who best know how to utilize their assets are the winners. Tanriverdi and Venkatraman specifically examine the relationship between

knowledge relatedness and the performance of diversified firms. Knowledge relatedness in three domains, products, markets, and managerial processes, was related to firm performance with firms showing greater knowledge relatedness also performing better on average. This result both shows the importance of knowledge with respect to firm performance and highlights the role that shared context plays in enabling the leveraging of advantages within a firm hierarchy. Though such acknowledgement of the importance of information in organizational choices is important as a reference point, information has also been identified as a significant organizational issue at an individual level. Information has been argued to be of particular importance to organizational decisions in situations where information asymmetries exist between principals and agents. Studies examining compensation and reward systems have pointed out the significance of such asymmetries in a variety of contexts (e.g., Rajagopalan and Finkelstein, 1992). Such asymmetries can become yet more problematic when principals and agents are separated (Roth and O'Donnell, 1996).

It is possible to consider knowledge as an asset just like any other, but such an approach downplays the importance of knowledge in the employment of other assets. It also fails to take account of the fact that knowledge, unlike most other assets, is often difficult to buy and sell. While some kinds of knowledge are relatively easy to transfer, particularly knowledge that has been reduced to explicit numbers, text, software routines, formulas, etc., valuation and pricing may be difficult (Varian, 1995). In addition, the ability to use purchased knowledge may be limited due to issues related to absorptive capacity (Cohen and Levinthal, 1990; Zahra and George, 2002). Many forms of

knowledge may be very difficult to transfer. One of the more widely used distinctions in the existing literature hierarchically separates data from information from knowledge (Alavi and Leidner, 2001). A useful distinction for the purposes of my research is between data/information, denoting elements that can be stored complete and undiminished in systems, and knowledge, referring to information complete with contextual information and linkages to other 'knowledge' and information. This latter kind of knowledge is difficult to share and is more likely to engender the incentive issues noted above.

Some authors have argued that knowledge is the primary reason for the existence of firms (e.g., Kogut and Zander, 1992). Their fundamental argument holds that the sharing of knowledge and information is more readily achieved between individuals and groups within a common organization than across individuals and groups that do not share an overarching organizational structure. Thus, firms are better at carrying out collections of tasks, especially complex tasks, that are related via knowledge or informational similarities. Foss (1997, p. 470) takes issue with such differentiation between knowledge and other assets, arguing that "It is not possible to tell very much of a story about why there should be firms in lieu of notions such as 'opportunism' or 'moral hazard.'" Thus, he argues that, while knowledge may be important to the firm and may factor in the organization of work, it does so within the bounds set by transaction and agency costs. Mayer and Nickerson (2005) implicitly accept this view when they identify three elements that make internal hierarchy more attractive when knowledge is a critical resource: expropriation concerns, measurement costs, and interdependence. While the

unique properties of knowledge (e.g., intangibility, non-rival nature, etc.) require special treatment, all three elements mentioned as drivers of firm boundaries in this study relate to concepts from agency and transaction cost theories.

## *Structure – Horizontal Organization of Work*

The second major element of the organization of work that this research seeks to clarify is that of structure – the organizational choices regarding centralized control of activities versus decentralization of decision rights. Hayek's (1945) arguments regarding efficiency of information flow in markets, where only price information and buy or sell offers need to be transmitted for efficient resource allocation, suggests that markets are the optimal form of organization. This argument can be logically extended, somewhat hyperbolistically, to the disintegration of all activities such that each and every production task is contracted for through a market with all productive agents acting as individual contractors. However, there are numerous potential market failures that drive internalization of functions. When forces such as market power, externalities, information sensitivity, and so forth exist and are salient, external markets may be unattractive when compared to internal production. Hierarchical organization within a firm may also serve to enhance the coordination of complex activities (Kogut and Zander, 1992). Nonetheless, since hierarchical organization does not offer the information processing mechanisms of competitive markets (the reduction of necessary information flows to price information and buy and sell offers noted above), different mechanisms for internal organization must be utilized.

The problem of internal organization has often been examined using the concepts of centralization and decentralization (Milgrom and Roberts, 1992). The first modern firms were centralized and organized along functional lines. Largely due to the difficulties of centrally managing disparate production activities in large, multi-product firms, many organizations moved to divisional structures with extensive decentralization coupled with an overarching central authority responsible for overall coordination. Such firms vary significantly in degree of decentralization with different firms and industries exhibiting wide variance in the number and importance of centralized activities and decisions.

In the conception used in this research, centralization and decentralization are used primarily to convey the location of decision rights within the firm. Decision rights may include decisions from strategy and investment to day-to-day operational management. The more of these decision rights that are reserved for a central upper management team, the greater the centralization. Conversely, the more decision rights are pushed out to the local operating unit, the greater the decentralization.

The choice between centralization and decentralization has been argued as a response to many needs regarding the organization of work, as noted above. Centralization may improve coordination and control while decentralization may enhance responsiveness and the alignment of incentives. The incentive alignment issue is somewhat different than the arguments regarding coordination and responsiveness, so these two arguments will be dealt with together first. Bennis argues that responsiveness is particularly necessary in turbulent environments, while Kuhn argues that “the degree of

required centralization is a direct function of the degree of required coordination" (Kuhn and Beam, 1972, p. 256). Transaction cost theory, as well, refers to the coordination costs associated with carrying out an activity. Though most research into transaction cost theory focuses extensively on the impact of physical assets on inter-firm transactions, by extending the logic a bit it can be seen that centralization and decentralization decisions would be made on the same basis, with attention to their relative impacts on internal coordination costs rather than external coordination costs. Thus, all of these approaches deal with information flows that either allow (1) improved coordination of activities or (2) faster or more effective decision-making regarding which activities to pursue and how to pursue them.

In addition to such arguments regarding coordination and responsiveness, incentive alignment has also been posited as a benefit of decentralization. Marschak (1965) argues that decentralized activities are better able to align incentives with desired outcomes. While his reasoning is part of a broader argument regarding the efficiency of centrally planned economies, the fundamental incentive argument is the same as that in agency theory (Eisenhardt, 1989). Spence and Zeckhauser (1971) make explicit the link between incentives and monitoring that is so important in agency theory. Their analysis focuses on insurance, but the insight that adverse incentives arise if one party to a contract cannot monitor effectively is broadly applicable to any context in which monitoring is difficult or impossible for a potential party to a transaction.

The concept of monitoring has been developed extensively by subsequent authors. For example, Maness (1996) makes a compelling case for the importance of

decentralized structure in cases where monitoring is difficult for the center to accomplish. Holmström and Roberts (1998) identify several similar circumstances. In all of these cases, the fundamental recognition that humans are self-interested actors is the same. Incentives are important because the problem of bounded rationality makes unitary control of any large enterprise infeasible (Simon, 1957, 1972), particularly when monitoring information is difficult to gather or transfer. Without such limitations on monitoring, the issue of markets and hierarchies would be moot (Hayek, 1945). In addition, the employment relationship in general presupposes use of knowledge on the part of the employee since 'commands' in the organization rarely specify every aspect of the task to be carried out (Simon, 1947, 1991). The impact of bounded rationality is most important in the current discussion because of its impact on the organization and management of work. Evans and Grossman point out in their analysis entitled "Integration" (1983) that companies often use decentralization mechanisms such as profit centers precisely because of the need for decentralized knowledge, expertise, and information in decision-making and control activities.

Decentralization is often discussed and assessed in terms of autonomy (e.g., Govindarajan and Fisher, 1990). When the need for decentralized knowledge or information is high, autonomy may be granted to local agents who possess the knowledge or information necessary to manage or carry out desired activities. Appropriate levels of decentralization/autonomy enable distributed agents to make use of their idiosyncratic information when and where it exists in conducting the organization's business. Such autonomy boils down to decentralized decision-making (Hülsmann and Windt, 2007). In

contrast to such related concepts such as span of control and routineness (e.g., Dewar and Simet, 1981), autonomy focuses on an agent's freedom of action regarding his or her own actions. The concept of autonomy implies some degree of ambiguity, but such ambiguity regarding organizational direction/control is necessary in order to reap the information processing benefits of decentralization/autonomy (Vancil, 1980). As Holmström and Roberts (1998, p. 90) put it, "Information and knowledge are at the heart of organizational design."

Agency theory recognizes the self-interest implied by the need for incentive alignment and addresses the problem of divergent goals between principal and agent. The primary approach used in agency theoretic analysis for assessing and dealing with opportunism issues, and for approaching the organization of work in general, is the analysis of contracting. As with transaction cost theory, the unit of analysis is the contract. However, the principal element that determines the best contracting approach, behavioral (hierarchy) or outcome (market) is the feasibility of different approaches to the issue of monitoring.

Although the concept of organizational structure is often applied at a macro level of analysis, the term is also useful in discussing organization at a more micro level. The concept of structure has been used to bridge between micro and macro levels of analysis. For example, Auster (1989) explicitly uses task characteristics, similar to those identified by Campbell (1988), as a bridge between levels of research in her examination of salary inequality. The link between tasks and structure has been of interest for many years, with Tushman and Nadler (1978) arguing that "task characteristics have been an important

concern to organizational structure researchers" (p. 615). For example, Hage and Dewar (1973) examine the impact of complexity and diversity of tasks on innovation at the firm level. Other researchers have examined the interplay between tasks and technology across levels of analysis. Comstock and Scott (1977) examine ties between individual tasks and subunit workflows and technology and structure, arguing that "technology should be thought of as representing the work of each level of organization" (p. 177). Hrebiniak (1974) examined effects at the group and individual levels in a study of links between job technology, supervision, and structure.

Task characteristics have also been used in the examination of context-structure-performance linkages by Drazin and Van de Ven (1985). Coleman (1984) points out the social assumptions that lie behind much economic analysis and the need to link micro-level, individual behaviors to macro-level phenomena in much research where simple aggregation is inappropriate. More recently, Grant (1996) distinguishes the importance of task level phenomena with respect to information/ knowledge transfer and firm boundaries and structure, pointing out that knowledge, particularly of the tacit variety, "is closely associated with production tasks, and raises the more interesting and complex issues regarding its transfer both within and between organizations" (p. 377). In an exploration of the relationship between technology and organizational design, Caves (2002) notes that "organization is not a constant, but rather a set of parameters that depend on the organization's tasks, the stability of its environment, etc." (p. 54). In addition, Barley (1986, 1990) has approached the question of structure by examining the impact of roles and technology and interactions between them. The current study

examines questions of structure at a similarly micro level, though it does so within the positivist framework rather than Barley's structuration approach.

This dissertation focuses on such micro-level analysis, examining task-level phenomena including the location of decision rights related to the conduct of specific tasks. If decision authority for a particular process or task is kept close to the firm's central management team, that process or task exhibits a high degree of centralization regardless of where geographically the activity takes place. However, geographic dispersion of activities often entails greater devolution of decision rights to geographically proximate management, particularly for day-to-day operational decisions, increasing the autonomy of such local units. In many cases such distribution of decision rights may increase the autonomy not only of the local operating unit, but also of the individuals who carry out the activities.

## *Governance and Sourcing*

The term "governance" is used in different ways by different literatures. The usage of the term here is drawn from the usage in Mahoney (1992, p. 559): "In the absence of agency and transaction costs, vertical financial ownership and vertical contracting are equivalent governance structures for achieving corporate objectives." This usage is commensurate with the use made in Williamson's work. For example, Williamson argues that "

> The overall object of the exercise essentially comes down to this: for each abstract description of a transaction, identify the most economical governance structure-where by governance structure I refer to the institutional framework within which the integrity of a transaction is

> decided. Markets and hierarchies are two of the main alternatives." (1979, pp. 234-235)

Matthews (1986) argues that the economics of institutions are valuably considered at a systemic level, across organizations, and at a more micro level, within individual organizations. The arguments presented by Matthews give particular attention to the issue of authority and decision-making. In *The Mechanisms of Governance*, Williamson argues that what he calls the institutions of governance are salient at the level of the individual transaction and also that "governance is also an exercise in assessing the efficacy of alternative modes (means) of organization… A governance structure is thus usefully thought of as an institutional framework in which the integrity of a transaction, or related set of transactions, is decided" (1996, p. 11). Elsewhere, Williamson characterizes transaction cost analysis as "an examination of the comparative costs of planning, adapting, and monitoring task completion under alternative governance structures" (1981, pp. 552-553), as noted above.

Agency theory also recognizes the governance implications of different modes of organization. The focus in agency theory is on the contract rather than on the transaction, but the distinction between outcome contracting (outsourcing) and behavioral contracting (hierarchy) (Eisenhardt, 1989) is quite similar to the market vs. hierarchy distinction in transaction cost economics. Issues related to goal divergence lead to agency concerns, and information asymmetries may impact contracting decisions and related organizational mechanisms and structures. Fama (1980) argues that firm level competitive forces coupled with agency concerns necessitate mechanisms for managing the performance of the entire firm and the individuals who make up the firm.

Under this conception of governance, sourcing represents an alternative governance structure from hierarchy (see Table 1 for a comparison of various uses of such conceptions of governance). The objective remains the facilitation of effective management of task completion, as with different approaches to internal governance, but the mechanisms used in governance and the relative impact of various task characteristics may be different. Thus, sourcing decision provide opportunities for instantiating different governance structures than those available via hierarchy, thus providing potentially more efficient or effective mechanisms for managing necessary tasks.

**Table 1**
**Governance Concepts – Boundaries and Structure**

| Concept | Description and Representative Literature | Usage in This Dissertation |
|---|---|---|
| Sourcing<br><br>(Outsourcing as "market governance", insourcing as "hierarchical governance") | "… for each abstract description of a transaction, identify the most economical governance structure- where by governance structure I refer to the institutional framework within which the integrity of a transaction is decided. Markets and hierarchies are two of the main alternatives." (Williamson, 1979, pp. 234-235)<br><br>"Governance is also an exercise in assessing the efficacy of alternative modes (means) of organization… A governance structure is thus usefully thought of as an institutional framework in which the integrity of a transaction, or related set of transactions, is decided" (Williamson, 1996, p. 11)<br><br>(Williamson 1979, 1981, 1996) | Sourcing is conceived of in this dissertation as a vertical mechanism of governance in line with Williamson's conception. Outsourcing is treated as an alternative governance mechanism to insourcing, including centralized or decentralized hierarchy. |
| Contracting<br><br>(Contracting subsumes hierarchical governance and market governance) | Agency theory focuses on contracting:<br><br>outcome contracting → "market governance", and<br><br>behavioral contracting → "hierarchical governance"<br><br>(Eisenhardt, 1989) | Outcome contracting informs sourcing (vertical organization of work)<br><br>Behavioral contracting informs hierarchical organization, including centralization and decentralization (autonomy) |

**Table 1 (cont.)**
**Governance Concepts – Boundaries and Structure**

| Concept | Description and Representative Literature | Usage in This Dissertation |
|---|---|---|
| Governance as boundary and/or structure | The analyses in Gurbaxani and Whang (1994) focus on firm size and allocation of decision authority<br><br>Conceptual foundations from Agency Theory and Transaction Cost Economics<br><br>No development of specific information constructs<br><br>No operationalization developed or empirical test conducted<br><br>(Gurbaxani & Whang, 1994) | Close in conception to the treatment of governance in this dissertation<br><br>Gurbaxani and Whang (1994) leverage the necessity of "acquiring, storing, processing and disseminating information" (p. 60) to construct arguments regarding the effects of IT and present anecdotal evidence of various effects.<br><br>This dissertation adds detail, operationalizes information localization as a construct, and conducts a preliminary empirical test of effects of information and targeted applications of IT on governance. |
| Outsourcing, Centralization, and Decentralization | The shared services literature often treats centralization as a step towards outsourcing utilizing the logic that a task that can be alienated from its immediate environment may more readily be alienated from the firm, as well<br><br>(Bergeron, 2003) | Treatment of outsourcing to centralization to decentralization (autonomy) is conceptually related to the shared services conception of centralization as an organizational choice between decentralization and outsourcing. |

## *Information Technology*

While this research attempts to illuminate the importance of information flow to both firm boundary and firm structure, it also seeks to leverage the concept of information flow to explicate the impact of information technology on the tradeoffs that firms must negotiate when selecting organizational elements. Researchers have used myriad definitions of technology as it relates to organizations. These definitions range from Perrow's (1972, p. 165) "tasks, or techniques of effecting the transformation" of raw materials into outputs to Hickson, Pugh, and Pheysey's (1969) differentiation among operations, materials, and knowledge technologies, to the more familiar use denoting, as Perrow (1972, p. 166) puts it, "machines or sophisticated devices for achieving high efficiency." The use of the term in this paper will hew closer to the latter definition, and the impact of information technologies in particular will be the focus of attention. Of course, given the widespread and increasingly frequent application of information technologies in the creation of Perrow's "machines and sophisticated devices," information technologies today affect production equipment directly in addition to their effects on the management of production. It is also important to note the potential of information technologies to enable reshaping of the processes of the firm, and thus to alter technology in Perrow's sense of transformational tasks and techniques. The expanded model presented here considers both of these potential effects of information technologies through the examination of their impacts on physical assets and information flow respectively.

Prior research has posited many different impacts of technology on organizations. Most researchers have argued that information technologies lead to less hierarchical, more specialized, or smaller firms (Brews and Tucci, 2004; Brynjolfsson, Malone, Gurbaxani, and Kambil, 1994; Dewan and Min, 1997; Fulk and DeSanctis, 1995; Leavitt and Whisler, 1958; Malone, Yates, and Benjamin, 1987; Zenger and Hesterly, 1997). Some have argued that smaller is not always better when it comes to technological change (Afuah, 2001). Others have argued that contradictory results abound (Pinsonneault and Kraemer, 1997; Robey and Boudreau, 1999). One of the more compelling arguments regarding the contradictory results for empirical studies is the argument that information technology as realized in organizations is an emergent phenomenon (Markus and Robey, 1988; Orlikowski, 1992). This view, following Pfeffer's (1982) concept of emergent action, argues that technology does not have a deterministic effect on organizations, but rather that organizations interact with technologies to create distinctive combinations and engender diverse effects. Indeed, these diverse effects may differ not only across organizations, but across different activities within the same organization as different agents or groups of agents interact with the technologies in their particular task environments.

While the emergent perspective on technological change has significant appeal and the theory presented in this paper recognizes explicitly the input of management and organizational actors in the process of determining implementation of technologies, the discussion herein uses the language of the technological imperative perspective (Pfeffer, 1982) in that it makes reference to the "impact" of technology. However, the application

of a given technology likely should not be the same in all task contexts and will not have the same effects in one context that it may have in another (e.g., Goodhue and Thompson, 1995). Though technology may not have a deterministic effect, technology can be seen to provide myriad opportunities for such emergent phenomena to occur, and some responses to these opportunities will be more effective than others.

Researchers have realized the importance of information on the organization of work since the early days of management research. Leavitt and Whisler (1958) were among the first to hypothesize organizational impacts of computer technologies, predicting dramatic recentralization of decision rights and greater programming of activities for lower level management. More recently, with the rise of internetworking technologies, and in particular the internet, more expansive arguments regarding the impact of information technologies on organization have been proposed. Malone, Yates, and Benjamin (1987) noted the impact of technology on asset specificity, but Gurbaxani and Whang (1991) were the first to present a comprehensive argument regarding the impact of information technologies based on the theories of agency and transaction cost that are foundational to this research.

Gurbaxani and Whang's analysis used transaction cost logic to explain the boundary choice between insourcing and outsourcing. Optimal firm boundaries are, in this view, a result of the tradeoff between transaction costs for carrying out activities externally on the one hand and internal coordination costs coupled with operational scale costs on the other. Regarding firm structure they argued that decision rights placement was a response to the tradeoff between decision information costs (the costs of decisions

being made with incomplete understanding of local information) and agency costs (the costs of agents pursuing self-interest rather than firm interests). This paper argues that information technology has the potential to alter boundaries and structure in many ways. In this conception IT may lead to greater insourcing and larger firms in some cases and greater outsourcing and smaller firms in others, just as it may lead to increased centralization of decision rights in some circumstances and greater decentralization and autonomy in others. Gurbaxani and Whang's paper also implies joint determination of boundaries and structure, in similar fashion to the arguments in this dissertation as expounded in more detail below.

Many other authors have noted the importance of information and technology in the organization of work since Gurbaxani and Whang's seminal paper. Brynjolfsson (1994) addressed the question of information and technology and their impact on organization. The economic analyses in his paper focused on the location of information and the flexibility of assets, both of which prefigure elements of the model presented below. Brynjolfsson argues that information technology will lead to smaller firms if it leads to better informed workers, enhances flexibility of physical assets, and allows direct coordination between agents (instead of mediated, centralized coordination). However, when economies of scale in information or network effects are high and where IT enables greater monitoring, he argues that firms will become more integrated. The connection between firm boundary questions, firm structure questions, and technology is also made in Zenger and Hesterly (1997). This paper argues that technology allows selective use of hierarchy elements in markets and market elements in hierarchies, creating a new kind of

disaggregation. These arguments echo those by Fulk and DeSanctis (1995) who theorized that communication technologies would enable new organizational forms, including networks as an alternative to hierarchies and markets. Information has also been held as the primary force in the determination of structure in many industries as it becomes an increasingly vital resource (Sampler, 1998; Sampler and Short, 1998). Sampler (1998) presents the concept of *knowledge specificity* and builds on the distinction between tacit and explicit knowledge (Nonaka, 1994). This concept of knowledge specificity is informative as a reference point for the discussion of information localization below. Information concerns in the organization of work have been discussed under the term information impactedness (Williamson 1971, 1973), information specificity (Choudhury and Sampler 1997, Sampler 1998), knowledge specificity (Subramani and Venkatraman 2003), Subramani 2004), codifiability and teachability (Kogut and Zander 1992, Zander and Kogut, 1995), and sticky information (von Hippel 1994), in addition to the discussion of the effects of information and information technology in Gurbaxani and Whang (1991). The relationship between these constructs and the construct used in this dissertation is summarized in Table 2 below.

Many studies have noted the potential for information technologies to mitigate problems of information transfer (Afuah, 2001; Child and McGrath, 2001; Fulk and DeSanctis, 1995; Nault, 1997; Zenger and Hesterly, 1997). Child and McGrath's (2001) paper on the impacts of information intensity makes extensive arguments regarding the organizational changes being wrought by the informational needs of firms. The effects of the internet on firm boundaries are extensively analyzed by Afuah (2003). He reasons

that the internet does not have unidirectional impact on firm boundaries. Rather, the effects of the internet are dependent upon other factors, particularly the firm's determinants of costs, information needs, and organizational technology (in the Perrow (1972) sense of tasks and techniques of transformation). However, many researchers have also recognized the importance of information tacitness (Afuah, 2003; Kogut and Zander, 1992; Nault, 1998; Sampler, 1998). Though technology may mitigate information transmission problems in many domains, some transmission problems may be less amenable to IT influence than others.

# Chapter 3: Model, Constructs, and Hypotheses

## *Dependent Variables*

The dependent variables used in this research deal with the organizational design choices that firms make when determining how to carry out activities. The contracting mode arguments from agency theory and transaction cost theory are used in discussing the three representative choices identified here: outsource, centralize, and decentralize. However, the primary focus is on the locus of the decision rights over the conduct of the activities under examination. Since decision rights over different aspects may be split in many different ways, the three representative choices are necessarily imprecise (or perhaps overly precise). The underlying organizational dynamic is theorized to be a continuum, with the three organizational choices functioning as useful foci for this discussion.

The type of contracting engaged in plays a substantial role in the identification of the dependent variables. The *Source* construct represents the decision between insourcing and outsourcing. Following the logic of agency theory, when activities are conducted outside of the organization that will use the resulting work product using *outcome-based contracting*, the activities are considered to be outsourced. When *behavior-based contracting* is used and the activities are conducted within the same organization that will use the output, the activity is considered to be insourced. When activities are outsourced, it is assumed that the decision rights for those aspects of

production that are not specified in the contract are left to the discretion of the agent that will produce the output.

For those activities that are insourced, decision rights may lie in different locations within the firm. Again, it is possible for such decision rights to be divided in myriad ways. When the majority of these decision rights are maintained under central control (i.e., remaining with more senior management), the activity is deemed to be *centralized*. In such centralized operations, the goals, methods, scheduling, sequencing, and delivery of outputs are determined by higher levels of management. The allocation of work and of assets necessary for conducting the work may also be done by the corporate center. On the other hand, when the majority of the decision rights over the conduct of an activity are distributed to personnel farther down in the organization, closer to the front line of operations, the activity is *decentralized*. In decentralized operations thusly defined, local operating units have extensive discretion regarding what to do and how or when to do it and correspondingly greater unit level autonomy. As noted above, discretion may extend to the individuals carrying out the activity, increasing their individual autonomy, as well. Thus, the difference between centralized and decentralized activities as conceptualized in this research is the locus of the decision rights over the various choices that must be made in the course of conducting those activities.

Many researchers have examined hybrid forms of production that lie between markets and hierarchies from the transaction cost perspective. Though such hybrid forms are interesting in their own right, they are not the focus of this examination. This study seeks to develop greater understanding the importance of information and information

technology applications in promoting different organizational designs. Rather than drawing distinctions regarding hybrid forms of organization, the focus is on the tendency of the organization of activities to gravitate toward one of the three prototypical organizational forms noted above depending upon differences in information required for managing those activities and different applications of information technologies.

## *Information Localization*

In this research difficulty in utilizing behavioral or outcome information beyond the immediate context is referred to as *information localization*. The impact of information transferability on firm design has received attention under a variety of names and in a variety of guises. Every modern organization faces difficulties in transferring information among personnel, between departments, and across firm boundaries. Information transfer may impact market transactions when the information necessary for verification of contractual commitments is difficult to gather or ambiguous in interpretation. This dissertation focuses on the impact of information localization and the potential of specific applications of information technology to mitigate information localization issues. While the concepts noted in this section are similar in that they focus attention on information issues, each focuses on different aspects of information needs and on different effect domains. (See Table 2 for a comparison of relevant conceptions of information.)

**Table 2**
**Information Constructs Comparison**

| Concept | Description and Representative Literature | Information Localization Similarities & Differences |
|---|---|---|
| Information Impactedness | Focuses on information transfer difficulty and governance across firm boundaries | Information localization synthesizes insights from transaction cost economics and activity theory: |
| | Difficulty is held to be primarily due to uncertainty and opportunism, particularly misrepresentation and adverse selection | Distinguishes factors involved in horizontal organization of work, as well as vertical organization of work (boundaries) |
| | Empirical work utilizing information impactedness construct is substantially less common than is the case with many other Williamson constructs | Focuses attention on the conduct and management of tasks rather than more specifically on ex-ante contracting and misrepresentation concerns |
| | (Williamson 1971, 1973) | Utilizes agency logic regarding outcome and behavioral contracting |
| Information Specificity | Developed as a construct to explain environmental scanning | Information localization constructs focus attention on task level phenomena and information requirements as the underlying drivers of organization, as opposed to broad, industry-level information |
| | Also used by second author in examination of industry structure | |
| | Theoretical focus in on acquisition of external environmental information for use within the firm | Emphasizes operational, task level rather than executive decision-making |
| | (Choudhury & Sampler 1997, Sampler 1998) | Attends to requirements for management of activities, including behavioral and outcome distinctions, as opposed to strategic, environmental factors |

**Table 2 (cont.)**
**Information Constructs Comparison**

| Concept | Description and Representative Literature | Information Localization Similarities & Differences |
|---|---|---|
| Knowledge Specificity | Used in analysis of inter-firm transactions and interorganizational governance, taking a TCE informed approach (similar to information impactedness)<br>Represented as a type of relationship specific investment and argued as a mechanism for improving competitive positioning in outsourcing contexts<br>(Subramani & Venkatraman 2003, Subramani 2004) | Information localization deals with behavioral, operational management concerns in addition to market-level issues and cross-boundary management<br>Leverages agency theory logic as well as transaction cost logic<br>Attends to hierarchical governance as well as market governance |
| Codifiability, Teachability | Represents the capacity to create a structure or framework of rules and relationships that can be readily communicated<br>Focuses on imitation of firm-level capabilities, transfer of capabilities, market opportunities (all essentially boundary questions)<br>(Kogut & Zander 1992, Zander & Kogut 1995) | Information localization examines individual-level impact of information rather than inter-firm or inter-division impacts<br>Leverages agency logic to distinguish outcome and behavioral information, organizational choices, and specific applications of information technology |
| Sticky Information | Developed as part of explanation of locus of innovation efforts when information is difficult to transfer<br>Limited attention to impact of different governance models<br>(von Hippel 1994) | Information localization considers ongoing operational information requirements rather than focusing on information transfer in innovation context<br>Examines management of activities beyond innovation |

Williamson (1971, 1973) uses the term information impactedness to express difficulty in particular kinds of information transfer, primarily focusing on issues regarding governance across firm boundaries. Information impactedness is, for Williamson, "A derivative condition that arises mainly because of uncertainty and opportunism, though bounded rationality is involved as well. It exists when true underlying circumstances relevant to the transaction, or related set of transactions, are known to one or more parties but cannot be costlessly discerned by or displayed for others" (Williamson, 1975, p.31). His 1971 description is more specific, arguing that information impactedness is related almost exclusively to opportunism and adverse selection issues. Thus, when one participant fears opportunistic behavior by another, particularly misrepresentation of capabilities, and when important information regarding the transaction is difficult for that party to obtain, market failures may result. This concept focuses almost exclusively on the impact of information asymmetry and transfer difficulty on boundary decisions by making transactions between separate entities more problematic and costly. Masters and Miles (2002) conducted an indirect examination of information impactedness, finding that ex-post uncertainty of performance reduced likelihood of using external labor arrangements. The limited empirical applications of the information impactedness concept have generally examined market failures utilizing Williamson's foundational arguments of opportunism and uncertainty with no attention to distinctions regarding the possibility that different types of information may have different characteristics and effects. IT application, when included, is argued to lead to greater outsourcing.

Information issues also have significant impacts on internal firm structure. When information is held at one level/location within the firm and decision authority lies at another, flawed decision-making often results due to delays and distortions in communicating information. One response to such difficulties is to decentralize decision-making, giving decision authority to those who hold the information. However, there are costs associated with such decentralization. The owner/manager (principal) and employee/worker (agent) may have different goals and it may be difficult for the principal to monitor and verify that the agent is actually doing what the principle desires the agent to do.

As noted above, knowledge specificity is an important reference point for the arguments presented in this dissertation. Choudhury and Sampler (1997) and Sampler (1998) introduce the term "information specificity" in discussions of environmental scanning and industry structure respectively. The focus in Choudhury and Sampler (1997) is on the acquisition of external information for use within the firm. The dimensions of time specificity and knowledge specificity are introduced and have rough correspondence to the concept of information localization introduced here, but in the Choudhury and Sampler usage there is little attention paid to operational characteristics. Rather, the attention is exclusively on executive and upper-level management decision-making. Table 4 in Choudhury and Sampler (p. 40) makes this focus clear by distinguishing levels of intraorganizational knowledge specificity in acquisition that place scanning responsibilities with the Decision-Maker, Subordinate, and Central Unit for high, medium, and low levels of specificity respectively. Choudhury and Sampler note

that “the acquisition of information was, of course, the primary focus of this paper” (1997, p. 42), indicating that operational characteristics and use are at most secondary concerns in their analysis. Sampler (1998) uses the same distinctions with respect to information specificity to develop propositions regarding industry boundaries and industry structure in the Porter (1985) sense.

Subsequent examinations, such as Christiaanse and Venkatraman (2002), use information specificity in a similar environmental scanning context. Christiaanse and Venkatraman argue that use of an IT system enabled a separation of information acquisition and information utilization. This paper argues that the use of a “dedicated, dominant interorganizational system” allowed a central unit to decrease effective knowledge specificity by performing analyses on raw data and disseminating filtered, codified information, allowing for more ready consolidation of some aspects of information processing while maintaining dispersed decision-making. There was not, however, any specific measurement of information specificity. Rather, the construct was used in the discussion of results. Legner and Schemm (2008) use the concept somewhat differently, applying it in an interorganizational context similar to knowledge specificity as discussed below. They examine information specificity in a case study of inter-organizational product information supply chains, using the concept in explaining dependencies between manufacturers and retailers. Much of the work following Sampler (1998) leverages that paper as background on industry or market transformations more generally (e.g., Amit and Zott, 2001; Nachum and Zaheer, 2005) rather than examining the information specificity construct in more detail.

The related concept of knowledge specificity has been used primarily in discussions of inter-firm transactions. Subramani and Venkatraman (2003) describe "domain knowledge specificity" as a type of relationship specific investment, expanding a conventional transaction cost economics view of inter-firm exchanges by drawing out the implications of intangible assets on quasi-integration and joint decision making. The study found that domain knowledge specificity was significantly linked to both of these interorganizational governance forms. Subramani (2004) examines the impact of applications of IT to supply chain relationships and the advantages that supplier firms draw from such investments in IT, finding that both exploitation and exploration uses of IT were associated with greater relationship specific investments. The value of such investment to suppliers seems to derive from better competitive positioning with respect to the buyer rather than from cost reductions. The authors' empirical tests of the concept focused on inter-organizational impacts and hybrid market governance forms (quasi integration and joint decision making), with investments in specific knowledge or processes expected to increase inter-organizational bonds. Domain knowledge specificity (DKS) was found to be significant and positively associated with both forms, while business process specificity (BPS) was marginally significant and positive for joint decision making only (Subramani and Venkatraman, 2003). Subsequent examination of applications of information technology found that use of a system provided by a leading customer showed effects on competitive performance with that customer, with effects being mediated by BPS and DKS in most analyses (Subramani, 2004). Neither study differentiated between types of governance or outcome vs. behavioral information.

Knowledge specificity has also been invoked in studies of knowledge management (e.g., Becerra-Fernandez and Sabherwal, 2001; Pedersen and Larsen, 2004; Chun and Montealegre, 2007). It has been applied in examinations of knowledge search in international cooperative ventures (Shenkar and Li, 1999), problems regarding effective knowledge markets (Guilhon, 2004), further examinations of scanning (e.g., Camponovo and Pigneur, 2006), and approaches to inter-organizational supply chains (Legner and Schemm, 2008). Schultse (2000) applies the concept of information specificity to the characterization of knowledge work in an examination of the production of information as opposed to/in addition to its use. The concept of knowledge as something held by individuals yet still bound to firms/organizations, though not referred to in terms of specificity, has also been used in the examination of transferability and competitive advantage (Kogut and Zander, 1992) and the evolution of multinational corporations (Kogut and Zander, 1993). Kogut and Zander distinguish dimensions of codifiability and complexity, adding teachability in the examination of multinationals. The focus of both of these studies is on the exchange of tacit knowledge within firms. At least one study, Carson et al. (2003), has used teachability as part of an examination of inter-firm collaboration. This study examined the use of trust-based governance and found that teachability, in conjunction with client task-related skills, collocation, and parallel task execution, was associated with greater use of such governance. The inclusion of client task-related skills, collocation, and parallel task execution suggest that the relationships exhibited a degree of integration that was dramatically greater than the prototypical inter-firm market transaction would entail. Thus, such transactions are not

examples of outcome-based contracting per Agency Theory or outsourcing per Transaction Cost Economics. Rather, such transactions would seem to represent manifestations of hybrid production somewhere between hierarchy and market.

In general, the uses of the concept of specialized knowledge, specialized information, knowledge teachability, knowledge transfer, etc. use the terms in the same broad contexts as the foundational papers use them. That is, in the context of environmental scanning and information gathering or the analysis of interorganizational exchanges. Perhaps the closest concept to information localization as developed here is von Hippel's "sticky information" (1994). Sticky information is used in a theoretical discussion of the locus of innovation efforts that involve information that is difficult to transfer. However, there is limited attention to the impact of different governance models given sticky information. Though all of these applications of the concept considered various conceptions of information flow or information transfer, none of them distinguishes between outcome and behavioral information or specific applications of IT in order to assess differences in impact on organizational arrangements.

Hayek's (1945) arguments regarding efficiency of information flow in markets suggests that moving transactions into the market should be the optimal organizational decision. Hayek argues that in perfectly competitive markets only price information and buy or sell offers need to be transmitted for efficient resource allocation. However, as noted earlier, there are numerous potential market failures that lead to the internalization of many transactions and activities. When forces such as market power, externalities, information sensitivity, or opportunism become issues, external markets may become

unattractive compared to internal production (Coase, 1937, Williamson, 1975). However, since hierarchical organization does not offer the information processing benefits of competitive markets (Demsetz, 1988; Hayek, 1945), different mechanisms for managing internal organization must be utilized. These mechanisms must, in turn, deal with different manifestations of the problems of goal divergence (Berle and Means, 1933), bounded rationality (Simon, 1947), monitoring difficulty (Alchian and Demsetz, 1971; Eisenhardt, 1989), etc., which, in essence, can be considered to be information flow problems.

Looked at in this way, the above points imply that information is a critical overarching element in management. Information is critical both for the management of activities and for the actual conduct of those activities. While Foss (1997) argues that the existence of firms is most readily described by reference to arguments in transaction cost theory and agency theory, these arguments are congruent with the notion that information and knowledge are very different types of beast than are physical assets. Both of these theories focus on the contract and difficulties regarding different approaches to contracting, but the underlying problems are driven in large part by the degree of information asymmetry.

The importance of information is particularly relevant in the agency theory concept of monitoring. Though the underlying concerns regarding agent self-interest remain critical, monitoring is essentially information flow. The more difficult is the specification, gathering, or transfer of monitoring information, the higher the monitoring costs. Transaction cost logic is similarly bound up with information flow concerns. In

the presence of full and complete information, the majority of the drivers of transaction costs effectively disappear. When information is lacking or asymmetric, transaction costs are generally higher. Thus, as noted above, rather than comprising a conflicting perspective, such recognition of the importance of information is complementary to elements from prior theories regarding firm boundaries and structure, such as opportunism and moral hazard.

The primary concern in agency theory is with the potential for goal divergence. Such divergence may be between the goals of the principal (owner) and the agent (employee) (Berle and Means, 1933; Demsetz, 1983), or it may be between different parties in a market transaction, another flavor of the principal/agent dichotomy, as in the transaction cost economics (TCE) concept of opportunism (Grossman and Hart, 1986). As in TCE, the contract is of central importance for dealing with such potential divergence. The concept of monitoring cost from agency theory deals with one approach to mitigating the effects of goal divergence and suggests different contracting[2] approaches to minimize such costs. These arguments regarding contractibility posit that, despite the efficiency advantages of market transactions, when outcomes are difficult to measure or when the relationship between effort and outcome is unpredictable, internal hierarchy may be favored over outsourcing (Eisenhardt, 1989). Empirical results have been consistent with the argument that measurement difficulties regarding outcomes lead to vertical integration (Anderson, 1985; Jones, 1987). Whereas outcome-based

[2] Following agency theory and property rights theory, the term contract is used to refer to the organizational choice for managing an activity, and the term contracting cost to refer to the cost of performing an activity using a specific approach, e.g., through outsourcing, or internally using a centralized or decentralized structure.

contracting ties agent interests to principal interests (assuming the contract is properly specified), behavior-based contracting relies on monitoring to ensure that the desired behaviors are indeed being engaged in appropriately.

If the principal can adequately specify agent behavior (i.e., what to do and how to do it) and monitor agent behavior, there is less opportunity for the agent to shirk and pursue divergent goals. In such situations it is efficient for the principal to use a *behavior based contract* where agent behavior is specified and monitored and the task is governed within the boundaries of the firm (in-sourcing). The counterpart of a behavior based contract is an *outcome based contract* where the principal specifies the output that the agent is expected to deliver. In this type of contract the agent is responsible for producing the specified output in return for compensation that is closely tied to the realized output. Such a contract controls for agent shirking regardless of the ability of the principal to monitor the agent's behavior since the agent's compensation is tied to the realized output. Outcome based contracting makes outsourcing feasible. For example, Zipflower.com, Inc., which grows and exports fresh flowers, wanted to expand internationally. However, reaching the international market required fast, reliable, and cost-effective shipping. Developing internal shipping capability for infrequent, low volume shipments would have been grossly inefficient, but the ease of information transfer regarding the desired outcome (e.g., delivery address and delivery specifications) allowed the shipping process to be outsourced to FedEx. Thus, relatively easy outcome information gathering and transfer makes outsourcing attractive. Of course, it is also possible to engage in a mix of the two contracting methods. However, focusing on the

representative underlying simple cases allows clearer development of theoretical and empirical insights, and these insights should be of use in the analysis of more complex cases involving mixed contracting, as well.

## Contracting mode and information localization

From the perspective of the organization of work, the difference between *outcome* and *behavior-based contracting* is the information necessary for specifying and measuring outcomes vs. the information required for specifying and monitoring behavior. This difficulty in specifying, capturing, and transferring information about the desired behavior or outcome is the *information localization* introduced at the outset of this chapter. The two contracting approaches noted in agency theory remain central considerations, but the decision of which type of contract to use is based largely upon information flow considerations. The difference in the type of information that must be transmitted in order to specify contractual requirements adequately and verify completion/delivery of those requirements will favor one contracting approach over another. Thus, information localization operates by making different contracting options more or less attractive.

Thus, *outcome information localization* is the difficulty in specifying, capturing, and transferring information about desired outcomes or outputs. Similarly, *behavioral information localization* is the difficulty of specifying, capturing, and transferring information about expected behaviors. These two types of information localization form the crux of the arguments regarding the organization of activities that follow.

It might be argued that outcome information and behavioral information are not reserved to outcome contracting and behavioral contracting respectively. However, as noted above, the primary element that determines the best contracting approach, behavioral (hierarchy) or outcome (market) is the feasibility of different approaches to the issue of specification and monitoring. As in the broad thrust of the core agency theory literature (cf. Eisenhardt, 1989), this dissertation construes such specification and monitoring to be in essence an information problem. If outcomes are contracted for, those outcomes then form the basis for determining adequate completion of the contractual obligations. Outcome information is herein used to indicate the information required for such monitoring of outcomes. Behavioral information includes information necessary for specification of desired behavior (managerial direction) and information necessary to verify agent behavior (Eisenhardt, 1989), and behavioral contracting is most often used in situations where it is difficult to specify outcomes adequately ahead of time or to link specific outcomes to underlying, often interrelated activities. The established arguments from agency theory hold that when outcomes can be adequately specified and measured, outcome contracting becomes feasible, and when outcome contracts are utilized, "the agent is more likely to behave in the interests of the principal" (Eisenhardt, 1989, p. 60). It is possible for firms to engage in outcome monitoring of agents within the firm, thought such monitoring is generally only a part of the relationship assessment. For the vast majority of employees, at least within the Western world, remuneration for employment is not piecemeal. Even where outcome metrics are utilized, compensation is generally only minimally based on specific outcomes, as in the case of bonuses and

bonus pools, though such bonus systems also often rely on subjective indicators (Ittner et al., 2003; Rajan and Reichelstein, 2006).[3] Bonus pools are, however, often employed as a means of promoting the exploitation of information that might otherwise be unused (Baiman and Rajan, 1995). Gibbs et al. (2004) found that incentives are more often based on subjective assessments in contexts involving investment in intangibles and extensive organizational interdependencies, both characteristics of knowledge work.

Arguing in the familiar terms of agency theory, in contexts where information about the desired output is more easily specified, captured, and transferred, outcome information transferability is very high (and accordingly *outcome information localization* is very low). Since in such cases outcomes are readily measured, and as in such cases behavior is generally more difficult and costly to monitor than outcomes, total contracting costs[4] are likely to be lowest when using outcome based contracting. Assuming that the least costly mechanism is the preferred mechanism, the level of information localization is based on the least costly information transfer for achieving a particular objective. Thus, in situations with low outcome information localization, the firm will face low information localization and all else equal will generally select external sourcing regardless of the difficulty of monitoring behavior.

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[3] In some cases, particularly those involving very senior management in very large, diversified firms, such bonus schemes represent the largest component of remuneration, but such cases are rare in terms of numbers of individuals involved. When such bonuses are tightly bound to metrics within the control of the recipient, they operate similarly to outcome contracting per agency theory. However, as noted above, even in such cases substantial leeway in interpretation often lies with the firm.

[4] Total contracting costs include the costs of negotiating, monitoring, and enforcing agreements. Consistent with Transaction Cost logic, I use this term to refer both to external and internal contracting.

H1: The probability of organizational designs favoring external, arms length production (outsourcing) over internal production (centralized or decentralized hierarchy) for a given task will be highest in contexts involving low outcome information localization.

However, in complex, dynamic, and unpredictable circumstances, it is often difficult to specify, capture, and transfer information about the desired behavior *or* outcome. Such situations have many contingencies that are difficult to identify and specify beforehand and difficult to capture and transfer information about. For highly uncertain tasks that produce potentially ambiguous outcomes (e.g., research and development), measurement of outcomes may also prove difficult, making outsourcing problematic. Specifying and measuring the appropriateness of behaviors may rely on highly contextual, localized information, making it difficult for management beyond the immediate context to monitor and control behavior effectively. Therefore, in environments where information about the desired behavior *and* outcome is very difficult to specify, capture, and transfer, both *outcome* and *behavioral information localization* are high.

For example, in industrial selling that relies on a high degree of interpersonal sales effort, it may be difficult to define and measure selling tasks. Sales in such environments may be dependent on multiple contingencies (e.g., economic environment, differences in company reputation and competitive offerings, demand conditions in different territories) that are difficult to anticipate and specify beforehand. The long lead times in such environments also make sales outcomes difficult to specify and measure,

especially when such measurement must be done on a fixed schedule (e.g., quarterly or annual review) that does not correspond to sales events. These factors indicate that sales tasks in such environments have very high outcome information localization, typically leading to behavioral control (Krafft, 1999). Because of the high outcome information localization, it is very difficult to manage such tasks through outcome based contracts. As outcome information localization increases, the cost of outcome based contracts increases steeply, and behavior based contracting becomes more appropriate. When both behavioral monitoring information *and* outcome monitoring information are highly localized, decentralization is optimal because of the difficulty of monitoring agent performance from the center and of effectively assessing market outcomes.

One way of assessing the degree of decentralization of management is to assess the autonomy given to individuals working in a particular context (Govindarajan and Fisher, 1990; Grimes and Klein, 1973; Richardson, et al., 2002). Granting autonomy to individual actors is one way of dealing with extreme localization of the information necessary for the appropriate conduct of activities. Autonomy make take many forms, with agents being allowed decision rights over such matters as what to do, how to do it, or when to do it (Breaugh, 1985, 1989, 1999). By allowing an appropriate degree of autonomy, organizations allow their agents (employees) to make use of the information when and where it exists.

One definition of such autonomous control put forward by Hülsmann and Windt (2007) states that "Autonomous Control describes processes of decentralized decision-making in heterarchical structures." A heterarchy is a system of organization that may

include overlap, multiplicity, divergent patterns of relation, etc. Heterarchy and hierarchy are not necessarily exclusive, and heterarchies may exist within hierarchical structures, alongside them, or as an overarching structure that contains them. Matrix organizations exhibit many of the characteristics of heterarchical organization, with many agents occupying roles with relatively equal authority and power over the same decision domain. Unlike the arguments regarding span of control and routineness (e.g., Dewar and Simet, 1981), the argument here is regarding the individual's autonomy within her own activities.

Applying the organizational logic of heterarchy is instructive in many engineering tasks where numerous contingencies and interactions need to be coordinated in a domain that often exhibits high information localization. In addition, the concept of individual autonomy is very useful as a measure of task level decision decentralization. When employees must produce outputs that deal with the numerous contingencies and interactions, the information load required to closely supervise these activities is often prohibitive. In such contexts granting agents significant individual autonomy may be expected to improve organizational performance.

H2a: The level of individual autonomy (the decentralization of decision rights for a given task to an individual) will be higher for tasks involving higher behavioral information localization.

Another potentially useful measure of decentralization at a task level of analysis is the degree of autonomy granted to the local work unit. This concept builds from research

on autonomy (Aiken and Hage, 1966; Andersen and Segars, 2001; Breaugh, 1989; Richardson, et al. 2002) with a focus on the local task unit rather than the individual. The organizational actors within local operating units generally share greater propinquity with their managers and concerns regarding the contextuality of information are greatly reduced. Thus, granting significant autonomy to such a local unit may be desirable. While information localization remains high, the proximity of the manager who must make decisions relying on this localized information to the context within which the information is salient facilitates more fluid information exchange and more appropriate decision-making.

H2b: The level of unit autonomy (the decentralization of decision rights for a given task) will be higher for tasks involving higher behavioral information localization.

When it is possible to adequately specify observable outcomes, the measurement and transfer of outcome information is relatively straightforward and uncomplicated. This is particularly true when outcome information can be reduced to numerical data. Behavior, on the other hand is generally more difficult to monitor than outcomes, particularly when such monitoring requires first-hand observation or collocation. However, in some circumstances the information necessary for carrying out a task will be firm specific but not localized within one division or operational group within a firm.

If coordination of effort between two or more functions/units is a substantial consideration, inclusion of both functions within a single hierarchy will have advantages. Such coordination is particularly difficult via markets if outcome specification or

measurement for some portion of the activity is difficult or costly. This kind of task includes any highly interdependent task that requires input from multiple subgroups. When contracting is desirable and behavioral information is not extremely localized, tasks are amenable to greater consolidation within the firm. For such tasks, the benefits of economies of scale coupled with the need to exchange firm-specific (but not task-specific) information make centralization more attractive.

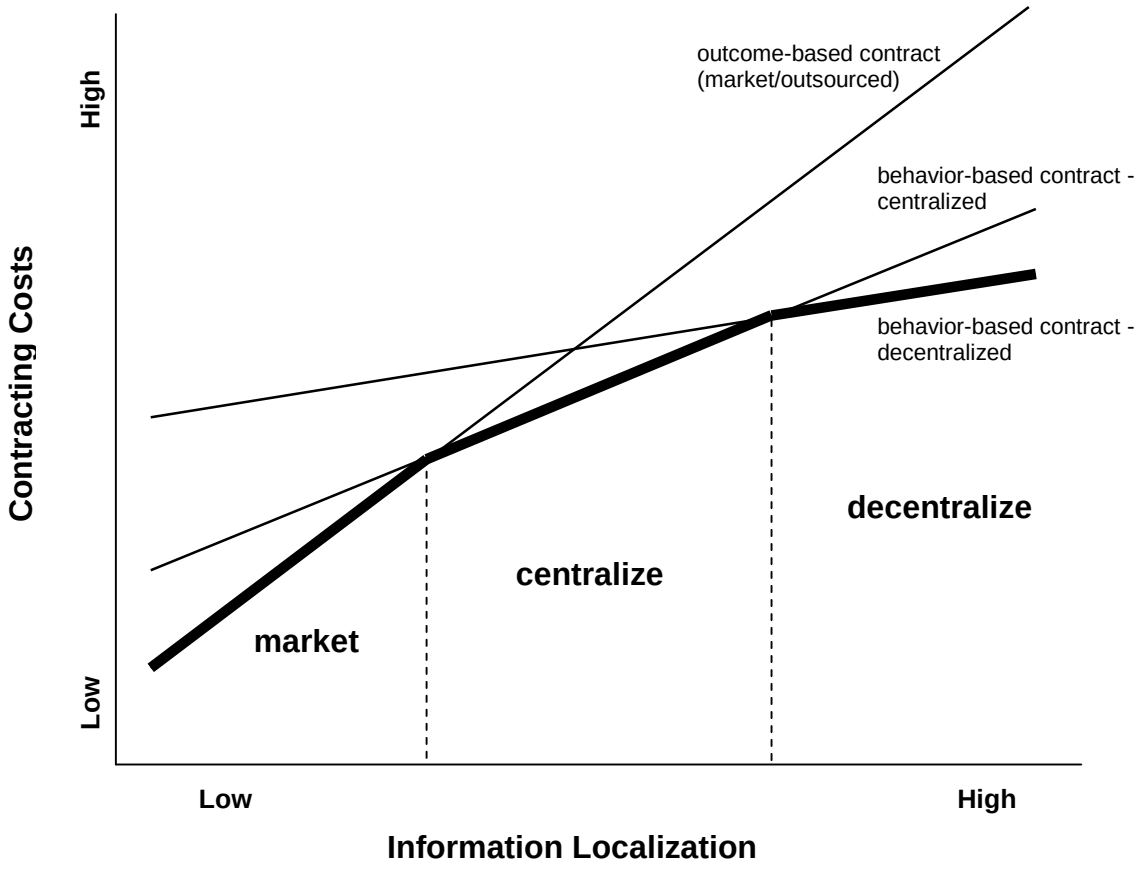
H3: The degree of centralization will be greater for tasks involving lower behavioral information localization.

These arguments are presented graphically in Figure 1, which contrasts outcome based contracting costs, behavior based contracting costs under centralization, and behavior based contracting costs under decentralization, across different levels of information localization. When outcome information localization is low and outcome information is easily gathered and transmitted, outsourcing is attractive because of the low cost of outcome based contracts coupled with greater potential for economies of scale. However, as outcome information localization increases, the costs of outcome based contracts increase more steeply compared to the costs of behavior based contracts due to the difficulty of monitoring/measuring outcomes and transferring monitoring information across organizational/contextual boundaries. If outcome information localization is high enough, the firm will insource the activity. Centralization is preferable (cheapest) in cases where outcomes are difficult to specify and behavioral information is local to the firm, but not specific to any unit within the firm. In such

cases, because of the relative ease of transmitting information that is common among units within the firm (though not across multiple firms), it is feasible to specify or conduct behavioral monitoring from the corporate center. However, centralization may incur extensive costs in the presence of highly localized behavioral information. If the required behavioral monitoring information is sufficiently rich in local context, more localized forms of control are necessary. When the managers at the center who are removed from the information sources are incapable of monitoring and making timely and well informed decisions, decentralization may be the most attractive, perhaps the only feasible choice.

## Figure 1

## Model Overview



The fashion industry provides a good illustration of the impact of information localization on organization design. Outsourcing has recently become the norm in the fashion industry, allowing producers to exploit low labor costs and somewhat commoditizable manufacturing processes. However, Zara, an apparel company located in La Coruña, Spain, defies this practice and still grows at an annual rate over 20% (Ferdows, Lewis, and Machuca, 2004). Instead of relying on outside partners, Zara designs and manufactures its products at a single centralized location. How has this led to success and growth? The critical elements of the equation are the coordination and speed necessary in order to respond quickly to customers' ever changing demands. By capturing local demand information from its retail outlets, the company can design, produce, and deliver a new garment from its centralized design and manufacturing center in La Coruña and put it on display in any of its more than 650 world-wide stores in 15 days, while competitors spend months planning for the next season. While the benefits of scale in manufacturing argue for outsourcing, the requirement to balance the coordination and information flow necessary for quick responses to information about fashion trends and the opportunity to leverage economies of scale in design and manufacturing make centralization an attractive option. Differences in local retail expectations and tastes and the need to capture such local demand information coupled with the fact that clothing is a high touch good leads to the greater decentralization of selling versus manufacturing.

## Application of Information Technology to Information Localization

Application of information technology to organizational information flows will generally be made so as to enhance the chosen organizational form. In managing

outsourcing suppliers/vendors, the ability to transfer outcome information is critical. Thus, when information technology is used to enhance the transfer of outcome information, the effect of higher levels of outcome information localization should be mitigated. This should lead to greater reliance on outcome contracting and greater use of the market versus internal production. In cases where outcome information localization is already low, this relationship may be weaker as such tasks are already amenable to outsourcing without extensive application of information technologies. For tasks that exhibit greater degrees of outcome information localization, on the other hand, application of information technologies should increase the feasibility and attractiveness of outcome contracting.

H4: Tasks for which use of information technology to facilitate outcome information transfer is high will be associated with higher levels of outsourcing than situations where such use of information technology is low, particularly in contexts with higher levels of outcome information localization.

The analysis of the use of information technology to facilitate the monitoring of behavioral information is more complicated. In highly complex environments involving unpredictable, turbulent, or poorly understood decision contexts, it may be infeasible to specify decision criteria in advance. In such environments management must rely on the capabilities of the agents undertaking the activity in question. Since the decision criteria cannot be specified in advance, the use of information technology to constrain the agent's decisions is of limited value and may lead to a negative outcome if the constraints are not

congruous with the specifics of a given decision. In such contexts, information technology may be employed to facilitate the capture of information regarding the agent's actions while the decision is left largely to the agent's discretion. This monitoring information might not be used to constrain to constrain the agent's decision-making excessively, rather providing enhanced discretion within broader guidelines. By designing systems to provide notice when decisions fall outside of specified boundary conditions, management could more comfortably delegate the remaining decision rights without fear of unacceptable loss of control. The information would also be available for performance evaluation at a later time. Such monitoring enablers may make management more comfortable with delegating greater decision-rights to the agent given the increased ability to monitor behavior for deviations outside of expected guidelines coupled with the ability to perform ex-post decision analysis in order to identify and reward/promote those agents who excel in such environments.

H5a: Individual autonomy (e.g., decentralization) will be higher for tasks involving high levels of information localization when information technology is applied to facilitate collection and transfer of behavioral monitoring information.

On the contrary, when information technology is used to facilitate monitoring in contexts involving low information localization (e.g., low complexity tasks in which uncertainty is minimal and contingencies are well understood), management may leverage such monitoring to ensure tighter control of these well understood processes. This monitoring may be largely automated, as in the use of workflow tools that impose

constraints on deviation from established procedures and provide performance metrics for individual employees. By enabling a greater degree of behavioral monitoring, management in such situation could ensure compliance with predetermined processes and reduce the level of individual autonomy.

H5b: Individual autonomy will be lower for tasks involving low levels of information localization when information technology is applied to facilitate collection and transfer of behavioral monitoring information.

Similar arguments to those regarding individual autonomy and the interaction between information technology and individual autonomy noted above are expected to hold at the unit level, as well. Since behavioral contracting is expected to dominate in internal employment situations, behavioral information localization should be important for management of the unit as well as management of the individual. Following the same logic used for individual autonomy, the application of information technology to facilitate information flows from the unit level to higher management should increase autonomy for high complexity tasks (within similar broad guidelines) and reduce unit autonomy for low complexity tasks for which tighter control is feasible.

H5c: Unit autonomy (e.g., decentralization) will be higher for tasks involving high levels of information localization when information technology is applied to facilitate collection and transfer of behavioral monitoring information.

H5d: Unit autonomy will be lower (e.g., centralization) will be higher for tasks involving low levels of information localization when information technology is applied to facilitate collection and transfer of behavioral monitoring information.

The application of information technology to the measurement and transfer of behavioral monitoring information is also expected to increase centralization. By enabling more senior management to access information necessary to make effective decisions of more activities, thereby facilitating the management of activities at a greater remove, higher use of IT to assess and transfer behavioral monitoring information should mitigate the impact of information localization on centralization. Thus, centralization is expected to be higher than would otherwise be predicted in contexts with high use of IT for measuring and transferring behavioral information.

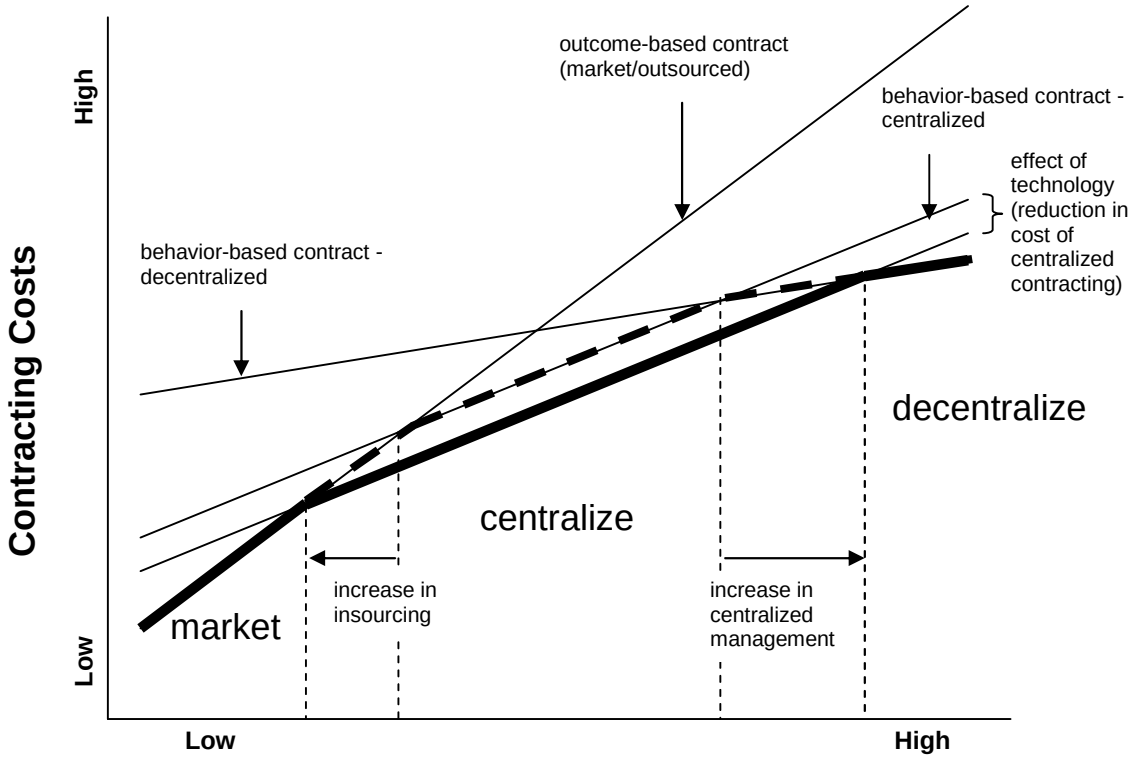
H6: Centralization will be higher, caritas paribus, for tasks where information technology is applied to the measurement and transfer of behavioral monitoring information.

Figure 2 depicts the impact of information technology on centralized behavior-based contracting. By reducing the costs of managing activities centrally, such application of IT increases the range of activities (in terms of their information localization) over which centralization is attractive. The change in attractiveness of centralization may alter firm structure through the centralization of some activities that would otherwise have been decentralized, or it may alter organizational choices regarding boundaries as some

activities that would have been outsourced become attractive for insourcing. Similar applications of information technology to enhance decentralized behavioral contracting (e.g., increase autonomy) or to facilitate outcome-based contracting (e.g., increased outsourcing) can be extrapolated from this figure.

## Figure 2

## Application of IT Example



## *Physical Asset Specificity*

A key argument favoring the use of markets is efficiency due to scale advantages. Since external markets serve larger pooled demand, specialists are able to focus on doing one thing, allowing them to do it more efficiently and effectively than any single customer can. However, transaction cost theory (Coase, 1937) notes that there are costs for the buyer to carrying out such transactions, particularly costs of coordinating with external suppliers.[5] If such costs are high, internal production becomes more desirable and vertical integration is a likely result. Contracting costs are particularly high in situations where transactions between entities require specialized physical assets (Williamson, 1975). The importance of asset specificity has been empirically validated in numerous studies (for a review see Shelanski and Klein, 1995). If there are limited alternative uses for a physical asset that is required for a transaction, and no alternative use has equivalent economic value, the possibility of hold-up increases. Contracting in such circumstances becomes much more costly, reducing the potential gains from using the market and increasing the attractiveness of vertical integration. While both the use of markets and the use of vertical integration involve contracting, contracts inside the firm leave substantial leeway in interpretation to the firm via the authority relationship (Simon, 1951). Thus, transactions that require specialized physical assets increase contracting costs and help to account for the fact that firms sometimes carry out

[5] Such coordination costs include the cost of selecting the supplier, specifying terms and conditions of the contract, monitoring performance with respect to the contract, and taking remedial action if necessary.

transactions internally rather than relying on specialists, despite the apparent loss of scale and focus advantages.

Specialized assets are also an important factor in the cost of production in many contexts. Williamson (1991) notes the importance of production costs in a full analysis of transactions, recognizing that production cost differences can in some circumstances overwhelm even large transaction costs. Demsetz (1988) also points out the importance of production costs in any discussion of firm organization. As noted above, because of scale advantages, market production often has a production cost advantage due to larger pooled demand, increasing the attractiveness of outsourcing. However, asset specificity generally increases production efficiency, increasing the attractiveness of insourcing provided that minimum efficient scale can be reached. The shift from prototyping methods, which are extremely flexible and require minimal specific assets, to highly specific production tooling for high volume manufacturing is testament to this efficiency effect of specific assets. Thus, even if scale advantages to market production are feasible, asset specificity may make internal production more attractive.

As an illustration, physical asset specificity is a major concern in pharmaceutical manufacturing. Production of active ingredients is typically done using highly specialized lines.[6] Though it is possible to build flexible facilities in which a single line can produce multiple compounds, such facilities are much more expensive to construct

[6] An active ingredient may be fashioned into pill, injectible, inhalable, etc. in more generic facilities, but the chemical compounds that are the basis of the drug are usually produced in highly specialized facilities.

and both productivity and utilization[7] are significantly lower. The lack of customization for specific compounds accounts for much of the drop in productivity, while any changeover to other compounds reduces utilization. Thus, given sufficient demand to make use of the output of a dedicated line, productivity and utilization concerns argue for production using specialized plants.[8] Also, given the high degree of physical asset specificity and the fact that demand for each active ingredient is specific to a single firm (in the case of patented products), there is no increase in scale through the use of outsourcing. For example, though Biogen was able to outsource formulation, packaging, warehousing, and distribution for its drug Avonex, production of the active ingredient remained in-house (Enriquez, Pisano, and Bok, 2002).

The literature on ownership, which grew out of the agency literature, also touches on the issue of physical asset specificity. Ownership and property rights are important because of the impossibility of writing complete contacts (Williamson, 1975, 1985). In the property rights view the firm is primarily a nexus of contracts (Jensen and Meckling, 1976). Grossman and Hart (1986) point out the importance of two distinct types of contractual rights: specific rights and residual rights. In situations wherein adequate delineation of specific rights is too difficult/costly or impossible, ownership, which boils down to possession of residual rights, becomes important. Hart and Moore (1990) expand on the flexibility and investment implications of different ownership arrangements, pointing out that a primary consequence of ownership is that the owner of

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[7] Productivity refers to the rate of production when the line is operating (e.g., output per time unit) and utilization refers to the time the line is actually in use for production (e.g., uptime as a % of total time).

[8] Time to market concerns make flexible plants attractive for speeding the launch of high value compounds, but usually only as a stopgap measure.

a physical asset can exclude others from the use of the asset. In the case of specialized assets and specialized knowledge for which there are few alternative uses, ownership issues can be particularly significant. I discuss these implications more fully below in the section on interaction between physical and information assets.

# Chapter 4: A Comprehensive Model of the Organization of Work – Directions for Future Research

While the empirical study conducted in this dissertation examines organizational configurations regarding task level activities, the theoretical arguments can in many circumstances be readily extended to activities in larger aggregations. Such extension is particularly straightforward when the activities involved in the aggregate are highly similar. Thus, some of the examples in this "directions for future research" chapter, in addition to the following case example, are presented at an aggregate level of analysis. The specific construction of hypotheses and appropriate analyses for examining relationships at aggregate levels will, of course, often differ from those used for task level examination. However, given the forward looking nature of this section, in particular, such difference represent opportunities for future work extending the empirical examination conducted below.

## Extension of Physical Asset Specificity to Firm Structure

As predicted by Williamson, for many tasks physical asset specificity is likely to play a significant role in influencing the design of organizations. Varying degrees of physical asset specificity make different boundary choices more or less appropriate. In addition, while physical assets have been found to be significant factors in firm boundary setting, it is also possible for assets to play a significant role in structure decisions. When assets are specific to a very narrow production function, decentralization becomes more

attractive due to the inability to use the asset for other functions, even within the same firm. Such acute asset specificity has been a strategic issue in many industries, with firms often seeking ways to reduce asset specificity by making the assets more flexible or by redesigning processes to make use of similar assets. For example, automakers have struggled with strategic issues related to physical asset specificity. In order to reduce the specificity of costly assembly lines, large companies have moved toward a platform approach that increases line flexibility. Toyota Motor Manufacturing Kentucky (TMMK), for example, is one such plant. Whereas in the past multiple automobile models required multiple assembly lines, TMMK's use of a common platform allows the Solara Convertible to be produced at low volume while the plant continues to manufacture the Camry at much higher volume.[9] Thus, platforming serves to reduce the physical asset specificity of assembly lines and allows production to move from decentralized production in which each model requires a dedicated line to more centralized production in which manufacturing facilities are common across multiple models.

## Application of Information Technology to Physical Asset Specificity

One potential use of information technology with respect to physical assets is in the allocation of scarce assets to particular tasks. Information technology can be used to track the use of assets and to enable rapid reallocation of idle assets that might otherwise remain dedicated to one task. Barring reallocation, these assets would remain idle

[9] "Mass Production Of The Solara Convertible Begins At Toyota Georgetown Plant." Available at: http://www.toyota.com/about/news/manufacturing/2004/03/08-1-tmmk.html

awaiting actual use in the task to which they have been assigned. Information technology can thereby reduce the effective specificity of a given physical asset by enabling more effective and more timely tracking and reallocation.

Another application of information technology to reduce effective physical asset specificity is the embedding of IT within the asset. Numerous examples of computer numeric control (CNC) machining centers attest to the efficacy of such embedding of IT in physical assets. CNC machining centers are capable of producing a wide variety of outputs with relatively minimal changes to the physical machine through the use of detailed programming instructions. Without such embedded IT capabilities, these machining centers would have to be specifically engineered for each specific output to be produced. Without computer control, repurposing such a machining center requires intricate redesign, fabrication, and installation of cams to enable the production of a new design. Prior to the advent of CNC capable equipment, this is precisely how such machining centers were repurposed. The use of information technology in CNC machining centers dramatically reduced the cost and time requirements for producing a wide variety of relatively similar outputs.

By enabling more rapid or effective reallocation of physical assets and by enabling ready repurposing of physical assets to produce other outputs, information technology can effectively reduce the specificity of physical assets. When outcome information localization is sufficiently low to make outsourcing feasible, this reduction in asset specificity further increases the attractiveness of outsourcing as the reduced specificity of the assets involved subjects the parties to less threat of holdup.

In situations that do not allow ready outsourcing, often due to substantial outcome information localization, the capacity to reduce physical asset specificity will result in increased attractiveness of centralization. The same benefits of reduced asset specificity outlined above apply, but they are realized entirely within the firm. Centralization of production allows greater economies of scale and potentially greater utilization of potentially expensive physical assets while avoiding prohibitive contracting costs associated with outsourcing in the presence of high outcome information localization.

## *Tying it all together*

Since asset specificity has proven to be a very useful concept for evaluating the organization of work with respect to firm boundaries, and since information is used both in the employment of other assets and in the monitoring and control functions of management both within individual firms and across boundaries, it makes sense to treat these concepts as co-determinants of the organization of work with respect to firm boundaries and internal decision structures. Thus *physical asset specificity* and *information localization* form the basis for the expanded model of the determinants of firm boundaries and structure presented below.

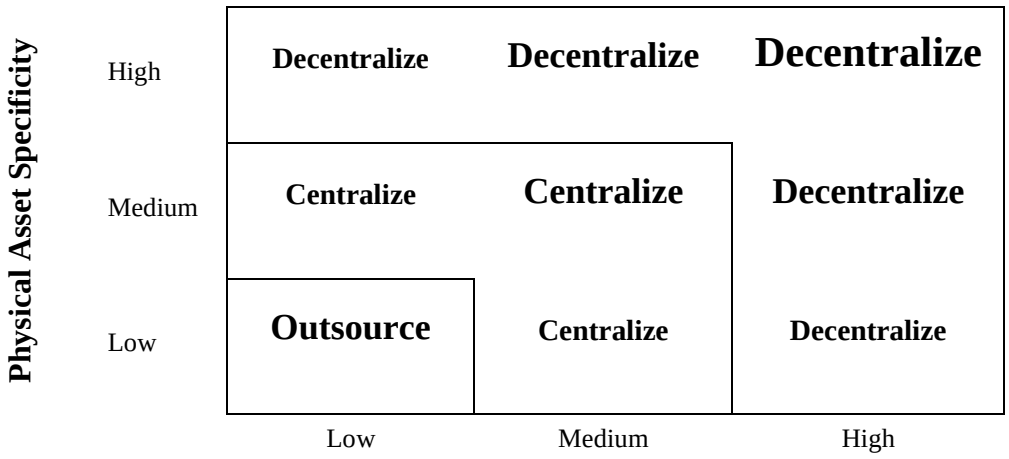
## *A framework for work organization choices*

Figure 3 shows the integrated framework for examining firm boundary and structure decisions. In one view, outsourcing is comparable to extreme centralization since outcome specification and contracting issues are limited enough to permit "centralization" of effort across multiple firms' boundaries. The upshot is that the more

specific the physical asset or the more local the information required for performing or monitoring an activity, the less amenable that activity is to centralization or to outsourcing.

## Figure 3

### A FRAMEWORK FOR EVALUATING WORK ORGANIZATION CHOICES




* Note that the size of the box associated with each boundary/structure choice does not indicate its prevalence. Also, the boundary/structure choices indicated are theorized to lie on a continuum. Interaction between dimensions may lead to more extreme results (bold entries indicate areas

When physical asset specificity and outcome information localization are low, outsourcing allows the capture of greater scale and scope benefits through the use of greater focus. In situations with more specific physical assets or where outcome information is more localized and context specific, centralization reduces contracting costs while allowing scale and scope benefits at the firm level (provided behavior

monitoring information is not prohibitively local in nature). However, highly specific physical assets may be of little use to others even within the same firm and highly localized behavioral information may require localized control to minimize contracting costs, leading to greater decentralization.

## Interaction between physical and information assets

Though it is possible to consider information as an asset just like any other, one important feature of information is its importance to the employment of other (physical) assets. Every use of a physical asset involves concurrent use of information regarding how to employ that asset. This suggests that these co-determinants of work organization regarding boundaries and structure may interact with each other. This interaction is consistent with the arguments in property rights theory (Demsetz, 1967; Grossman and Hart, 1986; Hart and Moore, 1990).

Property rights theory[10] argues that when multiple assets are critical to production, ownership and control of all assets under a single agent will tend to dominate other organizational forms (Klein, et al., 1978). This observation applies equally well to situations where one agent controls information that is critical for effective use of an asset. In such situations, ownership of the asset by this knowledgeable agent is the optimal arrangement (Hart and Moore, 1990). If an agent has such indispensable information, but does not control the physical asset necessary for production,

[10] The primary argument in property rights theory is that asset ownership is important for investment because of the inability to write complete contracts. If the disposition of an asset could be contractually determined under all possible contingencies, then its ownership would be irrelevant. The inability to write complete contracts leads to potential for less than optimal effort/investment in the involved assets. This problem of underinvestment can be overcome by joint ownership.

underinvestment in building and upgrading the asset becomes likely. In the same way, if the agent has unique information that can only generate value through use of the physical asset, then the asset and the agent should belong to the same organization for maximum efficiency. Joint ownership (i.e., the agent and the asset belonging to the same firm or operating unit) provides incentives for the agent to invest in developing skill and knowledge for generating value from the asset that other organizing mechanisms cannot provide. The importance of ownership has been reconfirmed in studies such as the Bakos and Nault (1997) analysis of electronic networks and Brynjolfsson's (1994) study of information assets.

This interaction between physical and information assets increases the strength of the attractiveness of the associated organizational design choices when the two factors have consistent, reinforcing effects on localization. As this discussion regarding the interaction between physical asset specificity and information localization suggests, the reinforcing effect between the two dimensions can accentuate the incentive to outsource, centralize, or decentralize. For example, in Figure 3, the tendency to centralize is higher when the physical asset specificity and the information localization dimension are both at medium level compared to when only one of the dimensions is at medium level. Similarly, the tendency to decentralize is higher when the physical asset specificity and the information localization dimension are both at high level compared to when only one of the dimensions is at high level.

P1a: The probability of organizational designs favoring external, arms length production (outsourcing) over internal production (centralized or decentralized

hierarchy) will be highest for tasks involving both low physical asset specificity and low outcome information localization.

P1b: The probability of organizational designs favoring internal, decentralized production over external production (outsourcing) or centralized production will be highest for tasks involving both very high physical asset specificity (subunit-specific) and very high behavioral information localization (subunit-specific).

P1c: The probability of organizational designs favoring internal, centralized production over external production (outsourcing) or decentralized production will be highest for tasks involving firm-specific (but not subunit-specific) physical assets and firm-specific (but not subunit-specific) behavioral information localization.

The filming of Titanic presents an interesting example of the interaction between physical and information assets. James Cameron, the director of the film, was responsible for overall production, and the producers felt that only he had the vision and skill to produce a movie that could draw large audiences. In order to film the movie, a vast, complex, and highly specialized set had to be constructed (the original being inaccessible under miles of water!). However, in large part due to the expenses Cameron incurred in building such a specialized asset, one that had few alternative uses, budget problems were encountered and the producers were reluctant to invest more. In order to ensure alignment and encourage the necessary investment, Cameron relinquished most of his fixed fee and agreed to a substantial alteration in his share of the movie's profits.

This left him with minimal compensation unless the movie became a blockbuster,[11] thus reassuring the producers that the investments he wanted to make were appropriate and necessary. Since the producers were convinced that only Cameron had the knowledge necessary to complete the movie using the highly specialized set built to his own specifications, the decentralization of decision rights to the local project manager, Cameron, was the most effective organization for the production.

[11] According to the Hollywood Reporter, March 1998, Cameron ultimately received approximately 10% of the film's gross – far more than he would have under his original deal.

# Chapter 5: A Case Example

## *Organization of the R&D Function in the Pharmaceutical Industry*

The R&D function is of critical importance in many industries, and the requirement for continual R&D is evident in the pharmaceutical industry where patents are a key element of the profitability equation. Most big pharmaceutical firms rely on new product introductions to maintain profitability. Smaller firms that are capable of producing therapeutic innovations also thrive, though they often require partnerships with larger players to commercialize their innovations. Given the critical importance of R&D in the pharmaceutical industry, and internalization being the surest course to maintaining control, one might expect all R&D activities to be internalized. However, this is not what is observed in the industry. Much pharmaceutical R&D activity is carried on outside of the firm. By assessing the elements of the pharmaceutical R&D process using the framework presented above, we can see how the interaction between information localization and physical asset specificity, in conjunction with the impact of IT on these two factors, leads to the observed outcomes.

Figure 4 presents a model that condenses the complexities of pharmaceutical R&D into three broad categories of tasks, (i) Pre-discovery, (ii) Discovery and development, and (iii) Trials, approval, and commercialization. Pre-discovery (stage 1 in Figure 4) involves basic data gathering, entry, and analysis to find disease causing mechanisms and to study the fundamental chemical and biological properties of compounds that may alter these mechanisms. While firms often pursue research in many

different therapeutic areas, attempting to find remedies for myriad diseases and conditions that affect different bodily systems, the foundational chemical and biological knowledge that is drawn upon in pursuing such research is widespread. In addition, the tasks associated with basic scientific analysis do not, in general, rely on firm specific physical assets, with some tasks requiring little beyond a PC or workstation. Even though the compounds under study may be firm specific (i.e., proprietary compounds), the knowledge required to perform basic data gathering and analysis is common to all scientific laboratories. Therefore, the level of information localization for such tasks is also very low. As the model presented above predicts, given the lack of specificity of physical assets and the low level of information localization, the tasks in the pre-discovery stage of pharmaceutical R&D are often outsourced.

**Figure 4**

**Simplified Pharmaceutical Research and Development Process**


The trials, approval, and commercialization stage (stage 3 in Figure 4) involves larger scale human trials, completion of regulatory requirements, and preparations for commercialization (e.g., handoff to manufacturing, preliminary marketing efforts). The

requirements for managing effective trials and conducting appropriate regulatory dealings are capital intensive, but the required assets are not specific to any therapeutic area. In addition, the information and knowledge required are not specific to any particular therapeutic area. In order to gain economies of scale in such activities, they are centralized in most pharmaceutical companies. In fact, some companies have begun outsourcing clinical trials to research service providers as the model predicts should happen. A recent study of over 6,000 clinical trials found that clinical trials involving simple data gathering regarding patients' drug responses are often outsourced (Azoulay, 2004).

In the discovery and development stage (stage 2 in Figure 4) specific compounds are targeted and tested for therapeutic value. Drug discovery requires scientists to recognize the relationship between chemical structure and biological activity, and to identify potential opportunities for therapeutic intervention. These activities involve the use of tacit knowledge that many scientists refer to as 'chemical intuition.' Such reliance on judgment and creativity suggests that the information required in drug discovery is highly localized, and helps explain the decentralization of these tasks. For example, in a recent reorganization, GlaxoSmithKline decentralized its R&D into six *Centers of Excellence in Drug Discovery* (CEDD) (Huckman and Strick, 2005). However, this decentralization applied only to the drug discovery and development processes where local information is critical. Pre-discovery efforts (stage 1) and clinical trials (stage 3) remained centralized, just as our framework predicts.

One aspect of pharmaceutical R&D that is difficult to explain at first is that much of the early development and evaluation of new compounds is done by small biotech firms. These biotech companies typically sell or license their technology to large pharmaceutical firms, but the initial drug developments (early stage 2) often take place outside of the large pharmaceutical companies. Why is this? Once again, attention to the degree of asset specificity and information localization is informative. The discovery of new compounds is a highly uncertain endeavor. It is difficult, if not impossible, to specify activities up front. Since even basic activities are difficult to specify, the resource requirements for carrying out such research are impossible to gauge with even moderate accuracy.

Monitoring is also problematic, owing to the very specific nature of the knowledge used in such endeavors. Even other scientists, if they are not well versed in the specific area of inquiry, find it difficult to assess the efforts undertaken in cutting-edge research. Since these activities often make use of highly specialized, custom built equipment in addition to highly specific knowledge, our model predicts that such activities are best managed at the most local level possible. This localization of effort allows for the extensive sharing of context-rich, localized information among those responsible for carrying out as well as managing these activities. Though such R&D efforts can be observed being purchased in the market, closer examination suggests that these start-ups are structured as this model predicts. In this regard, the start-ups act as the decentralized entrepreneurial arms of large pharmaceutical companies. Our interviews

with industry experts[12] confirmed significant purchase of research already accomplished elsewhere. This may look like outsourcing, but since most such development is done without extensive contractual specifications and obligations it is more akin to extreme decentralization.

This observation points out one additional interesting element regarding the unification of boundary and structure choices within a single continuum. To some degree it is also useful to think of the continuum as self-contained such that extreme examples seem to curve back toward the other end of the continuum, much as Stephen Hawking imagines the universe as edgeless. Just as outsourcing can be viewed as an extreme case of "centralization" that takes place across multiple firms, extreme decentralization may appear similar in many respects to outsourcing. As in this pharmaceutical research example, the extreme delegation of authority, responsibility, and market-based rewards used in some applications of specialized knowledge or unique assets may seem from one perspective to be extreme decentralization though it is conducted as a market transaction.

## *IT and the Organization of R&D in the Pharmaceutical industry*

IT is triggering significant changes in the drug discovery process. Technologies and techniques from high throughput screening (HTS) to rational drug design[13] (Cooke, 2005) are prime examples of IT enabled changes in pharmaceutical R&D, with some activities now moving to virtual screening (Shoichet, 2004). HTS uses computer

[12] Interviews (approximately thirty minutes to one hour in length) were conducted with four managers in the pharmaceutical industry who are involved in sourcing decisions for materials, production services, and intellectual property.

[13] Also called "structure-based drug design."

controlled robotic technologies to synthesize and test large numbers of compounds, thereby allowing the screening of thousands of compounds in the same time a technician using older, manual techniques might test a dozen. HTS enables a more structured, automated approach to the front end of the pharmaceutical R&D process (stage 1). This approach reduces the requirement for localized information by changing the focus from a sequential and targeted, but at times intuitive process to a parallel and expansive, shotgun search for high-potential molecules. Since these technologies and techniques are not drug specific, they have allowed increased centralization and outsourcing of much basic pre-discovery research.

Rational drug design aims to describe in detail the features of a molecule that would have the desired therapeutic effect. This approach removes much of the trial and error from the "shots on goal" approach to R&D enabled by HTS in which massive numbers of compounds are tested, often with only limited a priori expectation about their likely effects. Rational drug design involves an experimental cycle of proposing and testing potential solutions that can be expressed in mathematical terms and, thus, can be tested using digital simulation. Simulations allow scientists to explore their theories of why certain responses take place, and in that sense act as a virtual microscope. The scientist then uses the results to modify her understanding of the relationship between chemical structure and biological activity before repeating the cycle.

The magnitude of the data generated by development approaches like Rational Drug Design and technologies like HTS has necessitated the careful storage,

organization, and indexing of information,[14] leading to the development of the field of bioinformatics. Bioinformatics allows the use of computer technology and information science for the organization, interpretation, and prediction of biological structures. Again, since such capabilities are not specific to any single drug discovery effort and can be used for the benefit of multiple development teams, these IT assets and expertise are often centralized. This centralization allows achievement of efficient scale while still serving the needs of decentralized drug discovery efforts. Industry experts confirmed that firms have begun developing technology focused centers of excellence (COE) to help assimilate new technological capabilities that can facilitate drug discovery and development efforts (stage 2) that are most often decentralized.

In addition, the dramatic decrease in data communication costs wrought by IT has made outsourcing of many data gathering tasks feasible. This has significantly affected the organization of human trials (in stage 3) in pharmaceutical R&D. Human trials are primarily comprised of data intensive activities such as capture and storage of information regarding patient responses to treatment; activities that are simple and well defined, and have easily verifiable outcomes. These tasks have very low information localization and require little more than PCs and standard medical equipment in the way of physical assets. As our model predicts (P3a), such tasks are increasingly being outsourced.

In summary, the effects of IT on the organization of pharmaceutical R&D are not uniform. Different aspects of pharmaceutical R&D are experiencing different changes

[14] A high throughput lab generally produces in excess of 100 gigabytes of data per day.

that are driven by the impact of IT on information localization and physical asset specificity. Activities in pre-discovery (stage 1) that used to be primarily craft-based wet science are shifting toward an automated, mass-production process of parallel experimentation such as those using HTS. Reduction in information localization allows centralization or outsourcing of these activities. Similarly, advances in communication technologies enable the outsourcing of data-intensive but relatively standardized clinical trials (stage 3) to contract research organizations. The model of drug discovery (stage 2) that relied on brute empiricism is moving toward a new model that relies on understanding the biology of the disease. Technologies such as bioinformatics allow the creation of centralized data collection that enables scientists in decentralized drug discovery groups to readily retrieve, analyze, and simulate the structure and interactions of new biomolecules (Nightingale, 2000).

# Chapter 6: Methods

Data collection for this study of the impact of information requirements and characteristics on organizational design presented some interesting challenges. The specific information requirements and characteristics of any particular task will vary from those of any other task. In addition, requirements may vary dramatically between tasks necessary for completing the work of any company or even any single division or operating location within a company and any other company or division. Because of this variability in requirements from firm to firm, location to location, and even task to task, information was gathered on the impact of information requirements and characteristics on individual tasks. This approach necessitates primary data gathering since secondary data sources do not typically collect such micro-level data. A survey approach, though it gathers data regarding the perceptions of participants, has the advantage of allowing relatively cost-effective collection of a number of responses sufficient for statistical analysis. It also allows the tailoring of items to assess the aspects of the information-task interaction necessary given the new operationalizations for the information localization constructs.

While such survey research focused on individual tasks necessitates a longer chain of causal arguments to arrive at firm-level outcomes, it has the substantial advantage of providing insight at the most granular level of firm activity. It is also more in keeping with the precepts of transaction cost theory in which the unit of analysis is the individual transaction. In this era of increasingly dynamic transactions and ever more

atomized production operations in which operations routinely cross organizational boundaries, focusing on specific tasks offers the potential for greater insight into the forces that are changing the conduct of business.

## *Sample and Data Collection*

The sample for this study is drawn primarily from the rolls of a Midwestern manufacturer's association. The sampling fame allows the gathering of information from both large and small companies and from both public and private entities. Thus, the sample for this research covers a broader range of companies than a sample from a listing of publicly listed corporations would allow. Though the sample is limited to firms involved in manufacturing and the geographic scope of the sponsoring organization increases the likelihood of high automotive industry representation, these factors may serve to reduce extraneous influences.

The data were gathered from engineering groups within the respondent companies. This domain was chosen for the substantial information issues that characterize most of the work. Since engineering is primarily knowledge work, information transfer issues are likely both to be critical for the conduct of the work and to characterize the output of the work, as well.

## *Procedure*

Data were gathered via a survey implemented over the web. The restriction of the sample to professional engineers who are generally well educated and who use computers as their primary work tool should alleviate most of the concerns regarding this mode of

survey distribution. Some questions have been raised about sample effects of survey research (Grandcolas, et al., 2003), but these issues generally involve the distribution of surveys to a random audience, typically through web site links (e.g., in some marketing research). Others have noted the positive effects of computer mediated survey research, particularly the potential increase in honest, open response (Comely, 2002; Joinson, 2001). By restricting the survey to professional engineers working within the engineering function of firms operating in the United States, this study avoids many of the sample effect problems others have noted regarding web implementations of survey research.

Though no existing instrument assesses all of the variables under investigation in this study, survey items were developed using previously validated measures wherever possible (see Table 3). All items listed in Table 3 used a Likert-type scale ranging from 1=Strongly Disagree to 5=Strongly Agree, with two exceptions. The centralization measures asked, "At what level are the following decisions made?" with responses on the following scale: 1 - individual engineers, 2 - engineering supervisors, 3 - program managers, 4 - division management, 5 - above division level. The first three Unit Autonomy items requested responses on a scale of None=1, Little=2, Some=3, Much=4, and A Great Deal=5, while the last three Unit Autonomy measures used a scale of Never=1, Rarely=2, Sometimes=3, Very Often=4, and Always=5.

The items were checked with other academics and with four engineering managers with extensive experience in this domain. Their feedback was incorporated into the instrument in an iterative fashion. When the items were finalized, the final

survey instrument was tested with the sub-sample of five engineers and four engineering managers to ensure comprehensibility and effective flow.

Given the nature of the sampling frame it is difficult to assess non-response bias. However, ensuring that the survey instrument is accessible and relatively painless to complete helps to ensure that those who begin the survey will complete it. The International Handbook of Survey Methodology (de Leeuw, et al., 2008) notes that web surveys often suffer from higher rates of non-contact and break-off than other survey methods. In keeping with the findings that 10 – 15 minutes is about the longest a web survey can be without increasing risks of break-off or non-response (Czaja and Blair, 2005), the survey was kept relatively short. It was designed to take between 12 and 15 minutes to complete. In order to ensure that the survey could be completed within this length of time, the instrument was tested with a group of five engineers. These engineers also assessed the suitability of the item phrasing and the organization of the instrument for their work domain.

Once the instrument was prepared, an invitation was sent to the primary contacts at each firm on the rolls of the association asking the recipient to distribute the survey link to the firm's engineering staff. All communication with the members of the association was conducted through the association's managerial staff. The initial contact personnel at each firm were incentivized with an offer of an executive summary of the results of the study. An incentive was offered to individual respondents in the form of a drawing with odds of winning an MP3 player (iPod) of approximately 1 in 9. The final page of the survey allowed respondents to enter individual contact information in order to

be entered in the drawing for the prize. Though the survey instructions and the final page both made clear that the individually identifying information would be used only for the purposes of the drawing, the respondents were required to submit personally identifying information in order to be entered in the drawing. A follow-up message was sent 6 weeks after the initial invitation.

Though the sampling frame for this study is a convenience sample, examination of the membership of the organization chosen shows that it represents a wide cross-section of firms involved in manufacturing engineering. The organization membership includes firms of all sizes, from multi-billion dollar global manufacturers to small local shops and one-man consultancies. The members also represent firms with captive engineering staff who work on designs for internal use and providers of engineering services on an outsourcing basis. Though the confidentiality measures implemented prevented the collection and use of specific firm data in most cases, information regarding the size, both in terms of headcount and sales, of the firms in which respondents work was requested on the survey instrument.

## *Measures*

This dissertation aimed to answer questions regarding the impact of information localization, on the organization of activities within a firm. The specific hypotheses under investigation were as follows.

## Summary of Hypotheses

| No. | Hypothesis |
|---|---|
| **H1** | The probability of organizational designs favoring external, arms length production (outsourcing) over internal production (centralized or decentralized hierarchy) for a given task will be highest in contexts involving low outcome information localization. |
| **H2a** | The level of individual autonomy (the decentralization of decision rights for a given task to an individual) will be higher for tasks involving higher behavioral information localization. |
| **H2b** | The level of unit autonomy (the decentralization of decision rights for a given task) will be higher for tasks involving higher behavioral information localization. |
| **H3** | The degree of centralization will be greater for tasks involving lower behavioral information localization. |
| **H4** | Tasks for which use of information technology to facilitate outcome information transfer is high will be associated with higher levels of outsourcing than situations where such use of information technology is low, particularly in contexts with higher levels of outcome information localization. |
| **H5a** | Individual autonomy (e.g., decentralization) will be higher for tasks involving high levels of information localization when information technology is applied to facilitate collection and transfer of behavioral monitoring information. |
| **H5b** | Individual autonomy will be lower for tasks involving low levels of information localization when information technology is applied to facilitate collection and transfer of behavioral monitoring information. |
| **H5c** | Unit autonomy (e.g., decentralization) will be higher for tasks involving high levels of information localization when information technology is applied to facilitate collection and transfer of behavioral monitoring information. |
| **H5d** | Unit autonomy will be lower (e.g., centralization) will be higher for tasks involving low levels of information localization when information technology is applied to facilitate collection and transfer of behavioral monitoring information. |
| **H6** | Centralization will be higher, caritas paribus, for tasks where information technology is applied to the measurement and transfer of behavioral monitoring information. |

As the dependent and focal independent variables of this study were somewhat new, the research design incorporated more items for these measures. Though these items were developed building from prior literature wherever possible, no existing, validated instruments were sufficient to capture all of the constructs used in this research. The inclusion of multiple items allows the testing of measures for future use and ensures that robust, reliable factors can be identified. For control variables, where validated and reliable measures abound, fewer items were incorporated.

Table 3 summarizes the constructs examined, the measurement items used, and the literature support for the survey instrument.

*Dependent Variables*

The items for the *Individual Autonomy* construct are built upon theories of organization that distinguish autonomy from control. Because of the concerns regarding the reliability and validity of the original Aiken and Hage scales (Aiken and Hage, 1966, 1968; Hage and Aiken, 1967, 1969) as noted by Dewar, et al. (1980), the items for this study were adapted primarily from later studies in this domain (Andersen and Segars, 2001; Breaugh, 1985, 1989, 1999; Govindarajan and Fisher, 1990; Richardson, et al., 2002), though some of the original Aiken and Hage items that were also used in later studies were retained. Measures of *Unit Autonomy* were built upon those used in the autonomy literature and adapted to capture the degree of autonomy at the level of the local operating unit rather than the level of the individual (Andersen and Segars, 2001; Grimes and Klein, 1973).

*Centralization* measures were adapted from literature on organizational structure with a focus on the centralization of decision-making and activities. Again because of the concerns regarding the reliability and validity of the original Aiken and Hage scales, the items for this study were adapted primarily from later studies in this domain (Grimes and Klein, 1973; Miller and Dröge, 1986; Richardson, et al., 2002).

As in many similar studies (e.g., Poppo and Zenger, 1998), *Source* was measured as the degree of insourcing/outsourcing and was assessed with a single item 5-point scale (Insourced >90%, Mostly insourced, Mixed, Mostly outsourced, Outsourced >90%). Though some studies have assessed sourcing using multi-part measures (e.g., Ang and Straub, 1998), the task level analysis conducted here makes a single item more appropriate.

*Independent Variables*

*Information Localization* was measured using two sets of questions, one targeting the gathering and transfer of behavioral monitoring information and the other targeting the gathering and transfer of outcome monitoring information. *Outcome Information Localization* and *Behavioral Information Localization* items were adapted from the literature on information processing and information transfer within and between organizations with particular focus on studies of the impact of information and knowledge on boundary and structure choices (Anderson, 1985; Goodhue, 1995; Jaworski and Kohli, 1991; Mayer, 2006; Schilling and Steensma, 2002; Steensma and Corley, 2001; Zander and Kogut, 1995).

Respondents also assessed the use of Information Technology to facilitate information gathering and transfer regarding each of the two information localization constructs above. IT use to facilitate behavioral information gathering (*Behavioral IT*) and IT use to support outcome information gathering (*Outcome IT*) were assessed using scales adapted from studies of the impact of information technologies on the relationship between information and organizational design and information and market structure (Andersen, 2001; Andersen and Segars, 2001; Joyce, et al., 1997; Kettinger and Grover, 1997).

*Control Variables*

The controls for this study were drawn from those elements that have been widely argued to impact organizational form or autonomy or organizational boundaries. Some selectivity was necessary both to ensure appropriate survey length and due to the potential limitations of respondent familiarity. Many of the items for the measures of these control variables required very limited adaptation for use in the present survey.

*Physical Asset Specificity* (PAS) was assessed using items adapted from the transaction cost literature (e.g., Williamson, 1985) and studies that adopted the transaction cost view of asset specificity (Artz and Brush, 2000; Schilling and Steensma, 2002; Walker and Poppo, 1991; Walker and Weber, 1984; Zander and Kogut, 1995).

*Reputation* of suppliers and *Longevity* of contracting relationship and *Trust* were developed from literature on contracting relationships (Artz and Brush, 2000; Carson, et al., 2003; Poppo and Zenger, 1998; Steensma and Corley, 2000; Stroh, et al., 1996). S*witching Cost* measures were developed from the transaction cost literature, as well

(Artz and Brush, 2000; Mayer, 2006; Poppo and Zenger, 2002), but were not used in the present study.

*Scale* of production was measured using two items. The remaining controls were assessed using a single item each. Firm level information included *Total Employees*, *Total Engineers*, *Local Employees*, *Local Engineers*, all on a 6-point scale (see appendix). Data on *Sales* (in US dollars) were also collected. Individual level information regarding respondents included *Years Corp* (years working for this corporation), *Years Eng* (years working in engineering), and *Job* (level of current job on a 4-point scale).

## *Analysis*

Given the limited number of responses, a power analysis was conducted to ensure that sufficient data were available to detect any effects present. The power analysis was conducted using the method outlined by Mitchell and Zmud (1999). With 60 responses the power at $\alpha$=0.10 is approximately 80% for substantial effects. The power analysis results are presented in Table 4. Thus, despite the limited sample size, the data should support the discovery of substantial effects, if present. Given the limited sample size and the implied limitations on discovering significant effects at smaller effect sizes, this study remains somewhat exploratory. In order to detect more modest effects, more extensive data gathering may be required.

In order to assess the representativeness of the sample, estimates of average experience in engineering and tenure with current organization were gathered from three

people with extensive experience in engineering and long standing in the engineering community from which the sample was drawn. The consensus estimates were approximately 20 years experience in engineering (two respondents indicated about 20 years and one indicated 20+ years of experience) and 10 to 12 years spent with current organization (two respondents indicated 10 years and one 10-12 years). The average experience in engineering in the sample was 17.13 years and average tenure with current organization was 9.8 years. The average experience in engineering is slightly below the estimate of the experts polled, but the tenure with current organization is almost exactly the same as their estimate. One interesting fact uncovered by this follow-up was that the profile of engineers has changed substantially in the past ten to twenty years. As a result of deliberate efforts by many of these organizations to reduce costs, many older engineers with longer tenure in the organizations have been incentivized to retire. Two of the experts questioned volunteered that average experience a decade or more ago was likely closer to 30 years and tenure with current organization closer to 20 years. The third respondent strongly agreed with this assessment when asked about it specifically. Thus, the sample in this dissertation is largely representative of current engineering demographics in terms of experience and organizational tenure. Though this is not an exhaustive examination of representativeness, it does help to provide somewhat greater confidence regarding the representativeness of those engineers who comprise this relatively small sample.

Prior to detailed analysis the data were cleaned to ensure that all responses adhered to the same scale and descriptive statistics calculated. To validate the measures,

factor analyses were conducted for all independent variables with each dependent variable. In order to help with discovery of any underlying simple structure and to improve interpretability of results, Varimax rotation was used. To ensure the strongest construct reliability, separate factor analyses were conducted with each dependent variable. Principal Axis Factoring was used to determine the underlying factors (see Table 5). Since this approach to factor analysis focuses on the shared variance among individual measurements that may also have other unique sources of error, it is conceptually more appealing for data reduction analyses such as the one performed here (Warner, 2007). In addition, though principal components and principal axis factoring are very similar, "results based on principal axis factoring are more accurate in reproducing the population loadings" (Russell, 2002, p. 1637). Warner explains:

> In PAF, the analysis of data structure focused on shared variance and not on sources of error that are unique to individual measurements. For many applications of factor analysis in the behavioral and social sciences, the conceptual approach involved in PAF (i.e., trying to understand the shared variance in a set of X measurements through a small set of latent variables called factors) may be more convenient than the mathematically simpler PC approach (which sets out to represent all of the variance in the X variables through a small set of components) (2002, pp. 784-785).

In keeping with the recommendations in SPSS 17.0, at least three items were retained for each factor wherever possible. All factors with eigenvalues greater than one were retained. In all of the factor analyses performed, this point was reached at approximately

the point that the variance explained curve flattened out, indicating that the number of factors retained was appropriate given the dataset.

Prior to conducting further analysis of the data and testing the hypotheses of the study, the validity of the factors was examined. Initial expectation of face validity and content validity were enhanced by building upon prior research wherever possible and testing the instrument with academics and a group of practitioners experienced in the domain prior to administering the survey. This same group of practitioners also assessed the content validity of the instrument items and suggested changes prior to administration. A pilot study using a small sub-sample of the sample population was also conducted in order to confirm that the survey was comprehensible and covered the necessary elements within an acceptable completion timeframe (< 15 minutes), as noted above. Respondents in the pilot study confirmed that the survey instrument was clear, checked for errors, assessed the survey administration web tool, and reported the actual time required to complete the web survey. No substantial changes were made subsequent to the pilot study.

Factor reduction also helped to ensure adequate convergent and discriminant validity as only those items that loaded adequately on the observed factors were retained. While the research design gives rise to the possibility of common method variance and spurious internal consistency, the efforts undertaken to ensure face and construct validity prior to administration of the survey help to alleviate such concerns. Structural equation modeling may be of use in further reducing concerns of common method variance, but the number of responses in the current data set does not allow extensive use of such

modeling. The hypothesized factor structure was observed in the data, with the most trouble arising from two of the control variables for which existing measures were used largely unaltered. The Reputation construct showed cross-loading on the same factor as Trust in most analyses. The surface similarity between the two concepts makes this finding unsurprising. For the factor analyses for two of the dependent variables, stable factor loadings did not emerge until the Reputation construct was dropped.

While it may be argued that information related to task organization can be divided into two types, information required for managing a task and information required for conducting a task, the analysis of the data in this study does not find this difference empirically. Analysis of the information localization items shows two factors, one for behavioral information and one for outcome information. Items related to the management of tasks and items related to the conduct of tasks loaded onto one of these two factors. Thus, this study does not distinguish between managerial information and task conduct information.

A common proxy for reliability, internal consistency was assessed using Cronbach's alpha. Nunnally suggests that Cronbach's alphas greater than .7 are acceptable (1978, p. 245). The Cronbach's alphas for the factors in this study were all above this minimum acceptable level (see Table 6). The range of observed alphas runs from .724 to .901, and most of the factors have alphas above .80, indicating good internal consistency/reliability. The highest alpha (.901) is well below the values that would indicate that the items were simply redundant, failing to capture different aspects of the underlying factor.

The use of interaction terms introduces significant multicollinearity issues due to the high correlation between the underlying singular terms and the interactions. These multicollinearity issues are compounded by small sample size issues, from which its effects are indistinguishable (Woolridge, 2001). Preliminary analysis using terms without correlation effects reduced produced tolerances as low as 0.02, well below the 0.10 cutoff recommended in SPSS, and variance inflation factors as high as 52. The residual-centering approach (Lance 1988) was used to remove the correlation between the singular terms and the interaction terms of the variables. This approach entails regressing the interaction terms against the underlying variables (e.g., BEH_ITbeh is regressed against BEH and ITbeh). Then the regression residuals are used as the corresponding interaction terms in the regression. Since the regression residuals are, by definition, uncorrelated with the underlying terms, this approach addresses the issue of multicollinearity for these terms (see correlation tables for interaction terms) and provides a clearer interpretation of the main effects and the interaction effects.

While the information localization/application of information technology interaction terms present by far the most substantial multicollinearity issues, the control terms for local engineers and total engineers are also relatively highly correlated. In order to limit multicollinearity problems, some of these variables were not used in the analyses. Given the focus on engineering tasks, only the variables relating to engineering personnel were used in the models. Both of these variables are controls for the size of the engineering organization. Though they serve to capture somewhat different effects of size at the umbrella organization level and at the local level, they are rather highly

correlated. While some sources argue that tolerances less than .10 (VIF values above 10) indicate problematic multicollinearity issues (e.g., Hair, 1995; Netter, 1989), others argue that more stringent tests may be appropriate. The moderately high degree of correlation among variables in this dissertation may be particularly problematic given the small sample size and relative weakness of the effects observed. Menard (1995) argues that, although tolerances of less than .10 (VIFs greater than 10) almost certainly indicate multicollinearity problems, tolerance values below .20 (VIFs above 5) may be cause for concern. Though examinations of the variance inflation factors for models using both measures of engineering personnel show tolerances above .10 (VIFs below the recommended cutoff of 10), given the small sample and weakness of some model effects, the more stringent tolerance cutoff of .20 (VIF < 5) was utilized. Thus, only the TotalEng (total number of engineers) variable was retained in all models. In the resulting models all tolerances are above .25 (VIFs below 4), providing relatively high confidence that multicollinearity issues do not compromise the results and lead to unstable parameter estimates.

# Chapter 7: Results

Table 7 presents descriptive statistics and correlations for the variables in the analysis of factors influencing insourcing/outsourcing (*Source*). The correlations show very high correlation among the measures of total firm-wide employees (TotalEmp), local site employees (LocEmp), total firm-wide engineers (TotalEng), and local site engineers (LocEng). The correlations also show highly significant and negative correlation between outcome information localization (OUT) and sourcing (Source), where lower values of Source indicate insourcing.

Hypothesis 1 predicts that outsourcing will be higher in situations involving low outcome information localization. Though it is becoming more feasible to outsource work while retaining behavioral metrics, such outsourcing remains uncommon. Indeed, when "behavioral" metrics are rendered sufficiently precisely specifiable and measureable, they may be effectively transformed into outcome metrics. While in some domains, such as call center services, such specification is becoming more common, it remains nearly impossible to achieve in many other domains, such as engineering tasks as examined in this dissertation. Thus, in this analysis outcome information localization (OUT) was expected to be much more important than behavioral information localization (BEH) as a predictor of sourcing decisions.

First, a baseline model (Model 1) was run using only the control variables (see Table 11). None of the control variables were found to be significant. Model 2 adds the information localization variables, OUT and BEH. In this model OUT is marginally

significant at the .10 level and in the expected direction. In addition, the $R^2$ in model 1 of .186 improves to .238 in model 2. Thus, higher levels of outcome information localization are associated with lower levels of outsourcing, as predicted. The F-value for model 2 remains non-significant due to the high number of control variables included. Removing the non-significant controls, and regressing source on PAS, OUT, and BEH only, reveals that OUT remains significant. The p-value for OUT improves to .012 and the F-value of 2.493 is significant at the .10 level.

Hypothesis 2a holds that high levels of behavioral information localization will be associated with greater degrees of individual autonomy (IndAut). Since the theories built upon in this research construe autonomy as a characteristic of internal management of activities rather than the management of outsourcing relationships, behavioral information was expected to be of greater importance in this context. While outcome information may be of some use in managing internal activities, most firms utilize behavioral contracting for internal employees and rely on behavioral information to inform management. Table 8 shows descriptive statistics and correlations for the variables used in the analysis of individual autonomy.

A baseline model for Individual Autonomy (Model 4) shows that one control variable, job level (Job), is significant at the .05 level, while another, total engineers (TotEng) is marginally significant and the .10 level (see Table 12). As expected, the higher the job level, the greater the autonomy an engineer has ($\beta = .201$, $p = .057$). The numbers of total engineers has a negative coefficient, indicating that a greater number of engineers within a company is associated with lower levels of individual autonomy. It is

possible that firms employing larger numbers of engineers have greater experience with engineering tasks in general, and are thus able to exercise tighter control, limiting the situations in which an engineer would be expected to/allowed to exercise individual discretion. It is also possible that larger firms that employ larger numbers of engineers engage in different sorts of projects such that the task mix is different. If a larger proportion of work involves relatively routine engineering tasks, engineers working in such environments might experience tighter control and greater programming of activities, leading to a reduction in individual autonomy. Model 5 adds behavioral and outcome information localization to the control variables. The coefficient for behavioral information localization is positive and marginally significant ($\beta = .236$, $p = .062$). Outcome information localization is also positive, but is not statistically significant. This support for hypothesis 2a is encouraging given the sample size.

Hypothesis 2b argues, similarly to hypothesis 2a, that behavioral information localization will be associated with greater autonomy, in this case at the level of the local operating unit rather than at the level of the individual. Again, building from prior theories of autonomy, it was expected that behavioral information localization would play a more significant role than outcome information localization. Table 9 shows descriptive statistics and correlations for the variables in the analysis of factors influencing unit autonomy (UnitAut). A baseline model was run using only the control variables (model 7 – see Table 13). This model shows that none of the control variables are significant. Adding behavioral information localization and outcome information localization variables (model 8) shows that these are also non-significant. Though the root variables

of information localization were not significant, an interaction model was run in the interest of completeness. This model also showed no significant predictors. Since none of the models using Unit Autonomy as a dependent variable contained any significant independent variables, it is possible that the measure utilized for Unit Autonomy is flawed.

Hypotheses 3a and 3b present arguments regarding centralization. Hypothesis 3a holds that lower levels of behavioral information localization will be associated with greater centralization of decision making. Hypothesis 3b, on the other hand holds that higher levels of outcome information localization will be associated with greater centralization due to the reduced feasibility of outsourcing. These two hypotheses serve as a partial test of the argument in this dissertation that boundary and structure decisions regarding knowledge tasks are related and that both are influenced by information localization concerns, with the type of information localization playing a critical role in differentiating between observed organizational arrangements.

Behavioral information localization was expected to be of importance here since intra-firm contracts are usually behavior based. Reduced influence of behavioral information localization should allow greater centralization of activities across multiple operating units within the same firm. Outcome information localization was also expected to have a significant positive relationship with centralization due to the impact on the outsourceability of the task. It might also be argued that outcome information localization should be negative in contexts where activities are managed through quasi outcome contracts with internal "suppliers." Conventional wisdom holds that outcome

based contracting facilitates market transaction, which leverages greater economies of scope and scale. However, activities may be insourced for strategic reasons, and outcome information would, in such cases, be expected to have a negative relationship with centralization with lower outcome information localization being associated with higher centralization. Descriptive statistics and correlations for centralization analysis variables are shown in Table 10.

The baseline model for centralization (Model 10) shows that only physical asset specificity is significant among the control variables (see Table 14). Physical asset specificity is highly significant and is positive, as expected. Adding BEH and OUT to the model (Model 11) reveals that behavioral information localization is negative, as expected, but is not statistically significant. Outcome information localization shows the expected positive relationship with centralization, but again the effect is non-significant. In the case of outcome information localization the effect does, however, approach marginal significance ($\beta = .158$, $p = .150$). Also, the Pearson correlation between outcome information localization and centralization is significant at the .01 level. Removing the non-significant controls and running the model with only PAS, OUT, and BEH reveals that PAS becomes non-significant with the introduction of the OUT construct, which is significant at the .01 level ($\beta = .257$, $p = .006$). It is possible that further data gathering and larger sample size will be more revealing and help to clarify the findings with respect to outcome information localization and sourcing.

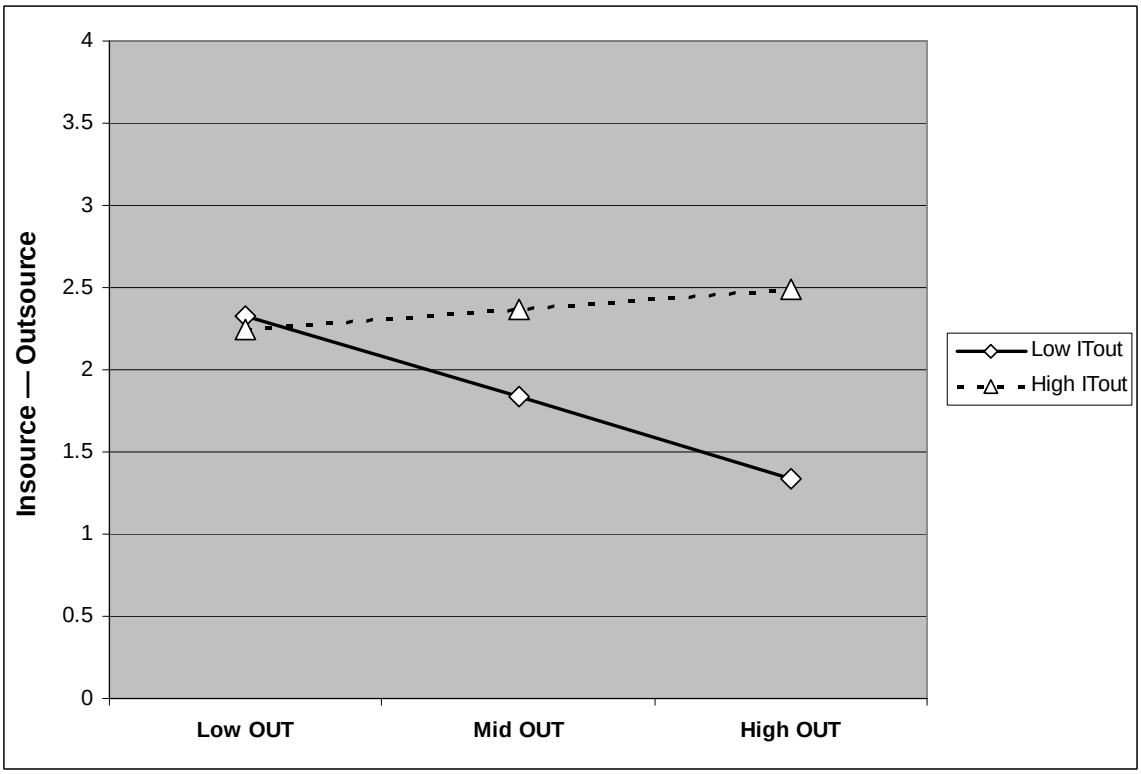
Hypothesis 4 predicts that the effect of outcome information localization on organizational boundary decisions will be mitigated by the application of information

technology to the gathering and transfer of outcome information. In order to test this hypothesis, the ITout construct (information technology application to outsourcing information) must be added. Since interaction between the OUT construct and ITout construct was expected, a term to capture this interaction must also be added (OUT_ITout). Model 3 adds these terms to model 2 (see Table 11). In order to facilitate interpretation of the interaction term, all independent measures were centered. As the model results show, while the root OUT term becomes non-significant and the ITout term is also non-significant, the interaction term ($\beta = .695$, $p = .042$) was significant ($p<.05$).

The effect of the interaction term is shown graphically in Figure 5. This graphic shows the simple slopes calculated with all variables not included in the graph at their centered, mean levels. The slopes are calculated at one standard deviation below and above the mean for Low ITout and High ITout respectively. The X-axis categories represent the mean (Mid OUT) and one standard deviation below and above (Low OUT and High OUT).

## Figure 5

### Sourcing and Information Technology Use Interaction




As the figure shows, the interaction between IT use and outcome information localization is as predicted. In order to check the significance of the slope differential, confidence intervals around the estimated slopes were calculated. The confidence interval for the High ITout slope (-.30 to .18) does not overlap the confidence interval for the Low ITout slope (-.79 to -.37). Thus, the difference between the two slopes is significant. Since the slope in the Low ITout case is significantly negative, the null hypothesis of no difference is rejected and a decline in outsourcing as outcome information localization increases is probable. With high use of IT to measure and

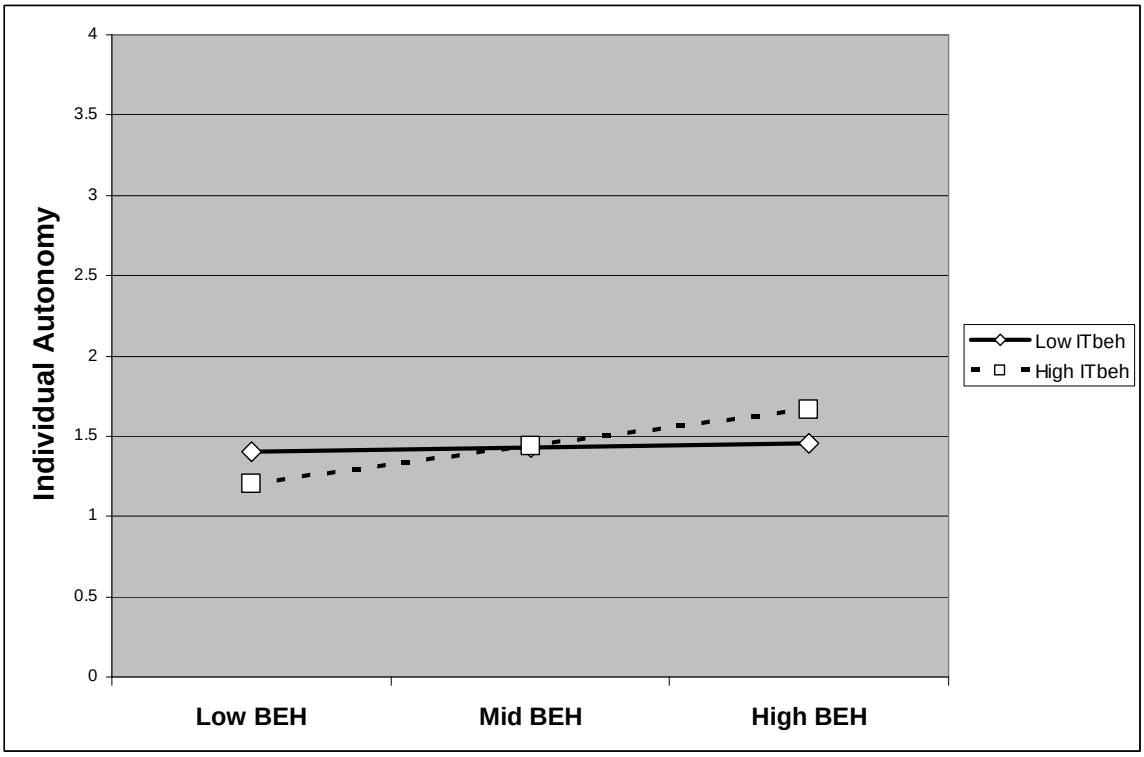
transfer outcome information, however, this decline in outsourcing as outcome information localization increases is mitigated. Though the slope in the High ITout case may not be positive since the confidence interval crosses zero, it is significantly shallower than the slope in the low ITout case. Thus, at a minimum we can be relatively confident that the effect of information technology application in this analysis is a reduction in the impact of information localization. This result provides support for hypothesis 4.

Hypotheses 5a and 5b argue that the effects of information localization on individual autonomy will be mitigated by application of information technology to the gathering and transfer of behavioral information. In order to test these hypotheses, the ITbeh construct (information technology application to behavioral information) must be added to the regression, and a term to capture the interaction between BEH and ITbeh (BEH_ITbeh) must be added, as well. Model 6 adds these terms to model 5 (see Table 12). Again, in order to facilitate interpretation of the interaction term, all independent measures were centered prior to running the model. As the model results show, the interaction term ($\beta = .360$, $p = .070$) was marginally significant ($p<.10$).

Figure 6 shows the effect of this interaction. Again, the simple slopes are calculated with all variables not included in the graph centered with the slopes for Low ITbeh and High ITbeh calculated at one standard deviation below and above the mean respectively. The X-axis categories represent one standard deviation below the mean (Low BEH), the mean (Mid BEH), and one standard deviation above the mean (High BEH).

**Figure 6**

**Individual Autonomy and Information Technology Use Interaction**




The interaction put forward in hypotheses 5a and 5b is as predicted. As with hypothesis 4, the confidence intervals for the slopes of the two lines were calculated in order to check for significance. The confidence interval for the slope of the line for Low ITbeh (-0.09 to 0.23) does not overlap the confidence interval for the slope of High ITbeh (0.27 to 0.59). The positive value for the High ITbeh simple slope indicates that in cases with low behavioral information localization, the use of information technology to gather

and transfer behavioral information is associated with lower individual autonomy than in cases with high behavioral information localization.

One explanation for these effects is that employees in these low behavioral information localization contexts are subjected to higher degrees of control and a reduction in their ability to carry out tasks as they see fit. Since management is able to grasp the salient elements of such low information localization tasks more readily, such a reduction in autonomy may allow more integrated collective work without a loss of effectiveness due to misunderstanding of the local context. Employees engaged in tasks characterized by high behavioral information localization, on the contrary, are given greater latitude than would otherwise be the case. This latitude allows them to make more effective use of the localized information they possess.

Hypotheses 5c and 5d argue, similar to hypotheses 5a and 5b, that the effects of information localization on autonomy will be mitigated by application of information technology to the gathering and transfer of behavioral information, but maintain that these effects will occur at the unit level. Since the underlying variables were not significant in this analysis, it is not appropriate to create an interaction term, but the interaction model results are included in model 9 for completeness sake (see Table 13). Again, none of the variables in this regression are significant, and it is possible that the measures for the dependent variable Unit Autonomy are flawed.

Hypothesis 6 argued that the application of information technology to the measurement and transfer of behavioral information would be associated with greater centralization than would otherwise be expected. The information technology terms were

added and interaction terms calculated in order to test this prediction. In this case, when the interaction terms are added only physical asset specificity remained even marginally significant in the regression ($\beta = .309$, $p = .083$).

As the above analysis shows, the models find significant results for applications of information technology as a moderator of the impact of information localization for both behavioral information localization and outcome information localization. There is, however, plausible argument for a mediating effect in which application of information technology alters the level of information localization for a task rather than interacting with that level as assessed in a moderation model. Therefore, tests for a mediation relationship between information technology application and information localization were also conducted. The results for BEH regressed on ITbeh ($\beta = .048$, $p = .142$) and for OUT regressed on ITout ($\beta = .135$, $p = .135$) were both non-significant, failing to support the hypothesis of a mediation effect.

This analysis implies that there is a significant interaction between the information localization components and the application of information technology (Venkatraman, 1989). IT does not so much reduce information localization, as a mediation model would imply, as facilitate exchanges that interact with the type of information localization to produce a complex set of effects. As Venkatraman argues, a moderation perspective is useful when the impact of the one variable varies across different levels of another. In this case, the impact of specific applications of information technology have different effects on the organization of activities depending upon the type of information necessary and the relative localization of that information. As

Venkatraman points out, there are potentially substantial analytical issues when more than two variables are involved in interactions. Since the arguments and empirical analyses presented here involve only two variable interactions, these problems are not germane to this study. In addition, though multicollinearity is often substantial when using a cross production (moderation test) with the underlying individual variables, "it is not problematic for establishing the existence of moderation effects" (Venkatraman, 1989, pp. 426-427). Removing such multicollinearity does, however, facilitate interpretation of other effects within the model.

# Chapter 8: Discussion and Conclusions

This research examined information localization as a determinant of firm design at a task level, including both insourcing-outsourcing and centralization-decentralization. The research also assessed the impact of applications of information technology on the effects of different types of information localization regarding task level organization. In order to test the predictions of this model, twelve hypotheses regarding different measures of firm design and information localization were presented. New measures were developed for the information localization and information technology use constructs, and these measures loaded well onto expected factors using principal axis factoring. Cronbach's alphas for the resulting factors showed good internal consistency/reliability. The hypotheses were tested using linear regression, and interaction effects between the information localization variables and information technology constructs were examined via simple slopes. The hypotheses were generally well supported, with both the information localization constructs and the interaction effects proving significant in two of the analyses. In this section I will examine the implications of the tests performed in greater detail, clarify the contributions and limitations of this research, and propose additional potentially promising avenues for future research.

Hypothesis 1 argued that higher levels of outcome information localization would be associated with greater insourcing and lower use of market transactions. Higher outcome information localization means that the information necessary for conducting

and managing outsourcing is difficult to gather and transfer between the contracting organizations. Support for this hypothesis with respect to outcome information localization is congruent with prior research on firm boundaries. Whereas prior research has examined information issues in more general terms, the findings in this dissertation confirm the intuition that the type of information matters. Outcome information localization operates as a significant element in firm boundary setting, while behavioral information localization operates very differently. This support also suggests that the outcome information localization construct developed in this research is an effective measure of such boundary spanning information transfer issues, at least within the domain studied.

Hypothesis 2a considered the relationship between behavioral information localization and individual autonomy. Individual autonomy is used as a measure of decentralization of decision making as decision rights are distributed to the individual workers rather than being reserved for management. In this way, individual autonomy can be viewed as a fundamental measure of decentralization at its limit. The support found for this hypothesis lends credibility to behavioral information localization as a measure of another important informational element of governance that is significant in the study of the organization of work.

Hypothesis 2b considered a similar relationship involving behavioral information localization, this time focused on autonomy at the unit level. Rather than assessing the autonomy enjoyed by an individual employee, this hypothesis tested the autonomy at the group level as assessed by participants within that group. The analysis showed no

significant relationships between the predictors and the unit autonomy dependent variable. It is possible that the measures of unit autonomy used in the study simply were not appropriate gauges of this construct. Indeed, in conducting the factor analysis it was found that several of these measures were unstable and cross-loaded onto other factors. Future research may be able to develop more effective measures of unit autonomy in order to more effectively test the hypotheses in relation to this construct. However, it is also possible that the relationships predicted do exist but are too noisy to detect within the limited data set for this study. Examination of this hypothesis with a larger data set should help to clarify this issue and provide more appropriate direction for future research.

Hypotheses 3a and 3b predicted relationships between information localization and centralization. Hypothesis 3a predicted that behavioral information localization would be inversely related to centralization as greater localization of information made management of activities at the local level more appropriate. Hypothesis 3b predicted that outcome information localization and centralization would be directly related since greater outcome information localization would make market transactions more costly, inhibiting outsourcing and driving activities inside the boundaries of firms.

Though the results showed these relationships to be directionally as predicted, they were not statistically significant. However, the correlation between outcome information localization and the centralization construct was significant and in the predicted direction. The lack of significance of the behavioral information localization construct could be due to these tasks being unsuitable for outsourcing because of higher

levels of outcome information localization, so many firms choose to insource them and manage them as a shared service. It is also possible that firms are attempting to get a handle on the outcome information handling necessary in order to outsource these activities, but that they have not yet found sufficient comfort with these processes to do so. This logic is consistent with some of the arguments coming out of the shared services literature (Bergeron, 2003). A follow-up study with a larger sample may be able to find significant relationships as predicted and to conduct a meaningful test of the predicted interaction effects. It is also possible that there are contingencies involved, and that a larger sample may allow such contingencies to be isolated in order to improve the explanatory power of the model. In any event a follow-up study with a larger sample will offer greater confidence regarding any findings or non-findings.

Though the two information localization variables were not found to be significant with respect to centralization, the relationship between physical asset specificity and centralization was significant. Higher physical asset specificity was associated with greater centralization (Table 14). While this is not exactly what the model predicts, it is in line with prior findings from the transaction cost literature and is congruent with the arguments made here. As physical asset specificity increases, transaction cost theory argues that outcome contracting will become more expensive/ problematic because of potential holdup issues. Thus, higher physical asset specificity should be associated with greater insourcing. If scale concerns are substantial, such insourcing might be expected to result in centralized operations. The factors for physical asset specificity and outcome information localization are also significantly correlated,

raising the possibility of an interaction effect upon which future examination may be able to elaborate. The decline in magnitude and level of significance of the PAS variable in Models 11 and 12 does, however, indicate that the added variables seem to capture part of the effect of physical asset specificity at work with respect to centralization. Again, a follow-up study utilizing a larger sample may allow the untangling of such effects and could have interesting implications for broader research into organizational designs.

Hypothesis 4 suggested that the use of information technology to facilitate the management of activities utilizing outcome information would mitigate the effect of outcome information localization on firm boundaries, increasing the attractiveness of outcome contracting and resulting in more outsourcing than would otherwise be predicted. Regression analysis with the IT term and an interaction term added shows that the interaction term is significant. Analysis of the simple slopes of the low information technology use case and the high information technology use case showed that high IT use was associated with a reduction in the impact of outcome information localization on outsourcing, as predicted. This lends support to the argument made here that the new information localization construct is amenable to influence by targeted application of information technology. Though the application of IT in cases where outcome information localization is already low shows no significant difference, this result is to be expected since such tasks are already amenable to outsourcing and thus may not benefit from the effects of information technology use. However, the application of information technology to facilitate management activities using outcome information when such

information is highly localized reduces the impact of this localization, enabling significantly greater use of outsourcing.

Hypothesis 5a and 5b argued that the relationship between behavioral information localization and individual autonomy would be influenced by the application of information technology to facilitate the management of activities utilizing behavioral monitoring information. Regression analysis showed the interaction term to be significant, and simple slope analysis confirmed that this influence was in the predicted direction. In low behavioral information localization contexts (hypothesis 3b), the difference between high information technology use and low information technology use cases is significant, supporting the argument made. Thus, information technology seems to allow the exertion of greater control over the conduct of tasks when behavioral information localization is low. The firms in this sample seem to be able to apply information technology such that prescribed work processes are followed more closely in such contexts.

In high behavioral information localization contexts, the difference is in the predicted direction, with higher IT use being associated with greater autonomy. However, this difference is not statistically significant. Yet given the findings for low behavioral information localization and the significance of the slope differential between high and low IT use, the results are promising. It is possible that this lack of significance is due to the limited sample size of the current iteration of the study. Future data gathering is planned that may allow a more thorough test of hypothesis 3.

Hypotheses 5c and 5d, regarding the impact of information technology application on unit autonomy, were not readily testable due to the lack of significance of the underlying information localization variables. Further analysis with an expanded data set may allow more useful inference regarding such effects, but the current sample does not support such analysis. The model is presented for completeness sake, but given the lack of significance of the underlying variables, the lack of significance in the expanded model is unsurprising.

Hypothesis 6 predicted that the application of information technology to management activities regarding behavioral information would increase the degree of centralization at any given level of behavioral information localization. When the information technology use and interaction terms were added, none of the variables in the regression remained significant. There are several explanations possible for this lack of significance, including insufficient sample size, lack of sufficient size among the firms sampled for substantial centralization to be present, and lack of sufficient knowledge on the part of respondents regarding their firm's organization beyond their own task domain.

Given the limited sample size, it is possible that a larger sample would show more significant results for this analysis. It is also possible that a large number of the firms surveyed lacked sufficient size to exhibit significant centralization. Though there was dispersion in the measures of centralization, the composition of the items in conjunction with respondents who may have lacked sufficient insight into centralization/ decentralization concerns at their firms may have resulted in responses that do not reflect true centralization. Since many of the respondents were lower level engineering

personnel, it is possible that their knowledge of wider firm organization was insufficient. Of course, the theory regarding centralization proposed here may simply need further development. If, as noted above, firms use centralization as a mechanism to prepare shared services activities for eventual outsourcing, the predictions regarding relationships between information localization and centralization may require refining. This theory base development, coupled with the possibility that a different sampling frame could produce more relevant responses, affords another opportunity for future research.

## *Contributions*

This dissertation extends current literature on organizational design and on the potential strategic impact of information systems. The development of the information localization constructs helps to clarify the important role that specific types of knowledge and information flows play in determining organizational forms and relationships. Information is necessary for managing relationships and conducting operations of any type, and clarification of this informational necessity vis-à-vis the predictions of agency theory enhances our understanding of these forces. The development and initial validation of a new instrument to test this aspect of information with respect to firm structure is also of value to the field. The significant findings of this study add support to the agency theory conceptualization of the forces at work in determining firm structure and boundaries and lend credibility to the extension of this research stream through the addition of the concept of information localization. This addition also serves as another connection between the logic of agency theory research and that of transaction cost

theory by clarifying a mechanism through which different agency theoretic concerns may impact transaction costs.

The clarification of the role of information systems in managing information flows and mitigating the impact of information localization opens new avenues for research into the potential for information systems to have a strategic impact in organizations. Though the underlying technology may still be argued to be a commodity, the appropriate application of systems to facilitate those information flows that are necessary to support the chosen organizational structure is of critical strategic import. Again, the development of new operationalizations of constructs to assess such applications of technology and the development and initial validation of an instrument for measuring them provides opportunities for future research to further clarify this strategic potential.

The more comprehensive theory presented in chapter 4, including the propositions regarding physical asset specificity, information technology impact on physical asset specificity, and interactions between physical asset specificity and information localization represent a potentially valuable extension of both agency and transaction cost theory logic. Though the dataset used in this study does not allow adequate testing of this expanded theory, the support found for the information localization constructs lends credibility to this further theoretical extension. Future research can build upon the theoretical arguments and propositions presented here and test this integrated model of the factors that interact with work organization approaches and associated boundaries and structure arrangements.

This research stream also has implications for research on organizational support technologies and technology and innovation management. By illuminating a new, constructive perspective on the informational needs of different organizations, the present research provides additional insight into communications system development and implementation that may enhance future research in these domains. In addition, the insights regarding information localization are of potential import in any research and development domain in which new, often highly context-specific information is being used or developed. Implications derived from the concept of information localization may also prove informative in the domain of international business. Functional context is important in determining the feasibility of information flow, but cultural context may be even more important in many circumstances, and may interact with the information localization constructs presented here. By clarifying the impact of such information localization on the management of work, this research may enhance both practice and theory.

## *Limitations*

This dissertation is subject to limitations, in particular limitations related to the limited sample gathered for this study. Findings of non-significance are particularly problematic given the limited sample. The necessity of assessing each dependent variable separately with the independent and control variables also raises potential concerns. Each of these areas of concern is dealt with in succession in this section.

As with all research this study involved tradeoffs, and certain limitations should be noted. Though reliability as assessed with Cronbach's alpha was good, in studies involving small sample sizes validity concerns may be magnified. However, "small" in this context is generally construed as <15 or <30. The sample size in this study with 60 respondents indicates sufficient sample size for such tests of reliability / internal consistency. In cases where questions regarding complex feelings or emotional states are assessed, such as in psychology, these concerns are often substantial. In the present context, most of the questions involve aspects of work life that are on the surface not emotionally fraught, helping to reduce such concerns. Nonetheless, the responses remain approximate indicators of the underlying assessment of the respondents. Concerns regarding the validity of the survey questionnaire were also addressed through pilot testing of the instrument with academics and practitioners familiar with the relevant research and functional domains respectively.

The sample was selected in order to ensure that respondents were sufficient familiarity with the domain under investigation such that responses would be meaningful. However, the fact that these respondents represent a single field of work context, engineering, presents some generalizability concerns. However, this domain is characterized by many of the same features that characterize knowledge work more broadly. Thus, it is likely that the findings of this study will be relevant at least to other knowledge work domains and should provide at least directional insight regarding any type of work in which information transfer issues are of significant importance for effective management. The fact that a high percentage of respondents likely came from a

single industry also reduces surface generalizability. However, there is no reason to think that engineering in the automotive industry is dramatically different from engineering in most other manufacturing industries. Differences between manufacturing and other lines of work may be more problematic, but again these results should provide at least directional insight. It is also possible that other cultures or other types of organizations will function differently. For all of these concerns, the theoretical foundation provides greater confidence that the forces at work here can be expected to play a similar role in other domains. Future research may extend this contribution by examining the impact of these constructs in other domains and other social or cultural contexts.

The relatively small sample size employed in this study limits the capacity to discover smaller effect sizes. Since even relatively small effect sizes may be of interest, the examination of the theory presented here utilizing a larger sample would be of interest. Though the current study has sufficient power to detect substantial effects at $\alpha$ = .10 levels of significance with greater than 80% reliability (see Table 4), simply doubling the sample size the study would allow for the detection of smaller effect sizes with 80% reliability. Even a moderate increase in sample size would increase the power of the tests such that substantial effects could be detected at $\alpha$ = .05 with greater than 80% reliability in all models. The sample size limitation may be particularly important for findings of non-significance, as in the case of unit autonomy and centralization in this study. However, another explanation for the lack of expected results in the centralization analyses is the relatively small size of the organizations in the sample, as indicated by the low values for TotalEng and LocEng. Nearly three quarters of the respondents indicated

that their total engineering staff numbered less than 31 engineers. Since centralization is likely to be more usefully studied in larger organizations with hundreds or thousands of engineers, the sample used in this study may simply not be effective for testing this organizational approach, particularly given the small sample size. It is also possible that this characteristic of the data gathered for this study reduced the ability to discover significant relationships regarding Unit Autonomy, which may be similarly related to organization size factors. Given the high representation of small to medium sized engineering groups in the sample, the findings of this study may be more readily generalizable to engineering organizations of small to medium size than to larger engineering groups.

In the cases of the Source and Individual Autonomy dependent variables, though significant effects were found among the variables of interest, the limited sample size contributes to the lack of significance of the second model in the case of source and the between models comparisons in the case of Individual Autonomy. Given the promising findings with respect to the variables of interest in these two analyses, a larger sample study would be worthwhile A larger sample would enable more effective testing of the variables of interest (increasing the power noted in Table 4) while maintaining the relatively complex models required in order to include theoretically relevant control variables.

The concept of information localization as tested here subsumes all behavioral or outcome information related to the management of a specific task. It is possible that distinguishing the information required in order to carry out a task in addition to the

information required in order to manage a task will produce additional insight. This study identified a single factor that captured information related to specifying the task and managing the task. Thus, possibility of more than one type of information localization was not empirically distinguishable in this study. However, it is possible that a different instrument designed to elicit information about different types of information localization would allow investigation of distinct impacts from different aspects of information localization.

The findings with respect to moderation and mediation may also relate to the data gathered for this study. It is possible that a firm's broader approach to information technology use may serve to reduce information localization. For example, firms that exhibit a high degree of information technology integration across business processes may as a consequence be able to transfer a wider range of information regarding those processes more easily and effectively. Since the data gathered here pertain to specific applications of technology, this dissertation cannot distinguish such effects.

No attempt was made to assess hybridization of organizational forms in this study. As the focus was on developing a the information localization constructs and assessing the impact of these constructs and of associated applications of information technology on three prototypical organizational designs for managing the conduct of activities, a detailed analysis of more nuanced organizational design was beyond the scope of this study. However, further work examining the relationship between information localization, applications of information technology, and more nuanced characterizations of organizational design would perhaps prove quite interesting.

The fact that the limited number of responses coupled with the number of survey items required factor assessment of each dependent variable separately may also raise concerns. Though these dependent variables are derived from prior research into firm organization, it is possible that some of these constructs represent independent constructs or rather dimensions of a multi-dimensional construct. A more thorough test of such a model with a larger sample size and utilizing more robust statistical tests might be able to distinguish such a multi-dimensional construct. Though such a test is not feasible with the current sample, it is of potential interest since if, indeed, such a construct is discovered, the implications for multiple streams of research into organizational designs would be dramatic.

Finally, this research involves new operationalizations, particularly regarding the information localization constructs, and a new instrument. This fact may have served to reduce the strength of the results as the instrument has not been widely validated. This limitation may be of less concern except in cases of non-significant findings, since it is unlikely to result in spurious findings of significant relationships. Further examination of the operationalizations and instrument with different groups of respondents and in different domains would facilitate more effective assessment of these measures.

## *Future Research*

The propositions included in chapter four present one avenue of future research. Testing the more comprehensive model that combines information localization and physical asset specificity would enable the testing of interaction effects between the two

constructs. This integration of concepts from agency theory and transaction cost theory, if found to be significant, would open exciting new avenues for research into the factors influencing organization design and the impact of information systems on these factors.

The most immediate opportunities for future work involve the examination of the predictions of the model utilizing a larger sample. Increasing the effective sample size would allow greater confidence levels for those tests where significant effects were discovered and might allow significant effects to be uncovered for other elements. A more robust test might also allow for the untangling of some of the complex effects observed in the current study, yielding still further avenues for future research. As noted above, a significantly larger sample would also facilitate the testing of the full model presented here, enabling the full range of predicted effects to be assessed while instilling greater confidence in the results obtained.

As noted above, one other potential extension of this research stream would be assessment of the impact of the information localization constructs in other types of work. While the management of engineering work, a form of knowledge work, was a priori expected to exhibit extensive requirements regarding information localization, management in other domains of work is likely impacted similarly by the informational requirements of behavioral and outcome contracting. Extending the research into other industries or other cultures/countries would also be of interest. In addition, the possibility that different types of information may exhibit different localization characteristics is not examined in the current study. Future research may be able to provide useful and interesting distinctions with respect to types of information that may be localized.

The current study conceptualizes the application of information technologies as a mechanism for facilitating the management of activities via behavioral and outcome information under different arrangements of organizational boundaries (both internal and external). Another possibility deserving of research attention is the potential use of information technologies to embed information/knowledge into processes or assets in order to more finely tailor outputs to organizational or market demands. Such embedding would be an attempt to improve effectiveness at the expense of greater localization. This approach might be of significant interest in domains where such tailoring is relatively easily accomplished or in domains in which information localization is already a significant challenge to broadly applicable processes. If such localization concerns cannot be mitigated by reducing localization, it may profit the organization more to seek to tailor such processes in order to obtain the greatest effectiveness gains possible.

As noted above, extension of this research by examining more nuanced characterizations of organization, including hybridizations of organizational forms, should also present ample opportunities for future work. In addition, examination of hybridizations of contracting modes in contexts involving tasks with different levels of information localization and information technology application might also be of interest. The increasing use of metrics once considered firmly within the realm of behavioral information for managing outsourcing relationships is of particular note. Though the creation of extensive and detailed measurement regimes and reporting for such metrics essentially transforms them into outcome metrics, such innovations in the organization and management of outsourcing represent a substantial change in the way outsourcing is

managed. Any effort that provides greater clarity regarding the factors associated with such arrangement and their relative success would be of significant value to both research and practice.

In conclusion, this dissertation presented synthesized constructs regarding the localization of information and the application of information technology to reducing the effects of such information localization, an instrument for gathering survey data regarding these information localization constructs, and the results of an initial test of these constructs and their relationships with organizational boundaries and structure. The results suggest that information localization is a useful addition to the researcher's toolkit for analyzing factors that influence firm boundary and structure choices, and indicate that further study is warranted. A comprehensive theory is detailed and propositions to guide further research are presented. Thus, in addition to providing preliminary evidence that information localization is a useful addition to the organization design theories, this dissertation helps to establish a foundation for future research examining the interplay between information, physical assets, information technology, and the organization of work.

# Appendix 1 – Tables

## Table 3

### Constructs, Measurement Items, and Supporting Literature

| Construct | Item no. | Item text | Supporting Lit. |
|---|---|---|---|
| Behavioral Information Localization | beh1 | A useful manual describing how to perform this task can be (has been) written. (reverse coded) | Goodhue (1995), Zander & Kogut (1995) |
| | beh2 | New personnel can easily learn how to complete this task by studying a complete set of manuals. (reverse coded) | |
| | beh3 | This task frequently requires us to deal with ad hoc, non-routine problems. | |
| | beh4 | It is easy to determine if an engineer working on this task is working diligently. (reverse coded) | |
| | beh5 | Only managers close to this process can determine if engineers are performing their tasks as expected. | |
| | beh6 | It is easy to monitor the steps employees go through to complete this task. (reverse coded) | |
| | beh7 | It is difficult for management to monitor specific employee activities involved in completing this task. | |
| Outcome Information Localization | out1 | Performance targets for individual employees who carry out this task are clearly specified. (reverse coded) | Anderson (1985), Jaworski & Kohli (1991), Mayer (2006), Schilling & Steensma (2002), Steensma & Corley (2000) |
| | out2 | It is difficult to specify beforehand all of the elements necessary for the output of this task to meet our needs. | |
| | out3 | Performance in this task is ambiguous – it is difficult to tell how well an individual employee is doing. | |
| | out4 | The amount of the work completed when performing this task can be quantified and measured easily. (reverse coded) | |
| | out5 | A brief, inexpensive test or inspection can determine the quality of the output of this task. (reverse coded) | |
| | out6 | It is easy to produce comprehensive reports on production that allow accurate assessment of output. (reverse coded) | |
| | out7 | Only local (physically proximate) customers or supervisors can assess the quality of work completed. | |
| | out8 | Managers who are not directly involved in this task can easily tell when the work has been completed. (reverse coded) | |
| IT Application to Behavioral Information Localization | ITbeh1 | Our firm uses information technology to identify the appropriate steps for completing this task. | Andersen (2001), Andersen & Segars (2001), Joyce, et al. (1997) |
| | ITbeh2 | IT allows us to create workflow tools for this task that enable participants to follow our standard processes more easily. | |
| | ITbeh3 | Our firm uses IT to capture detailed information about specific employee activities in this task. | |
| | ITbeh4 | Our firm uses information technology to capture specific information about how employees carry out this task. | |
| | ITbeh5 | We use IT to capture specific information about the steps employees go through to complete this task. | |
| | ITbeh6 | IT is used to communicate detailed information about the activities of employees involved in this task. | |
| | ITbeh7 | Managers use IT to remotely monitor the activities of employees performing this task. | |
| IT Application to Outcome Information Localization | ITout1 | We use IT to create more complete specifications of the output required from this task. | Andersen (2001), Andersen & Segars (2001), Kettinger & Grover (1997) |
| | ITout2 | We use IT to spell out detailed production requirements to clarify customer and supplier expectations for this task. | |
| | ITout3 | We use information technology to assess the quantity of work completed in this task. | |
| | ITout4 | We use information technology to collect specific information about the quality of work done in this task. | |
| | ITout5 | We use information technology to monitor the output from this task, as it is being produced (in real-time). | |
| | ITout6 | We use IT to make information about output (from this task) available to the (internal or external) 'customer.' | |
| | ITout7 | We use IT to receive output information from the (internal or external) supplier that performs this task. | |

## Table 3 (cont.)

### Constructs, Measurement Items, and Supporting Literature

| Construct | Item no. | Item text | Supporting Lit. |
|---|---|---|---|
| Centralization | At what level are the following decisions made? (1 - individual engineers, 2 - engineering supervisors, 3 - program managers, 4 - division management, 5 - above division level) | | Grimes & Klein (1973), Miller & Dröge (1986), Richardson, et al. (2002) |
| | cent1 | The goals/objectives for this task | |
| | cent2 | The methods used for carrying out this task (details about how the task is done) | |
| | cent3 | The sequencing of activities for this task | |
| | cent4 | The scheduling of this task | |
| | cent5 | Delivery dates and priority of the elements of this task | |
| | cent6 | The number of engineers required for this task | |
| | cent7 | Allocation of the work among available engineers | |
| | cent8 | The machinery or equipment to be used for this task | |
| Individual Autonomy | IndAut1 | I am allowed to decide how to go about getting this task done (methods to use). | Aiken & Hage (1966), Andersen & Segars (2001), Breaugh (1985, 1989, 1999), Govindarajan & Fisher (1990), Richardson, et al. (2002) |
| | IndAut2 | This task is such that I can decide when to do particular work activities. | |
| | IndAut3 | I have some control over what I am supposed to accomplish in this task (what my supervisor sees as my task objectives). | |
| | IndAut4 | Engineers themselves have significant input in deciding the goals for this task. | |
| | IndAut5 | Management or my supervisor focuses on the attainment of specific targets for this task and allows me considerable discretion in deciding the best way to achieve these targets. | |
| | IndAut6 | For this task, little action is taken here until a supervisor approves a decision. (reverse coded) | |
| | IndAut7 | For this task, a person who wants to make his/her own decisions would be quickly discouraged. (reverse coded) | |
| | IndAut8 | For this task, even small matters have to be referred to someone higher up for a final decision. (reverse coded) | |
| Unit Autonomy | UnitAut1 | How much say do engineering supervisors have in deciding the goals for this task? | Andersen & Segars (2001), Grimes & Klein (1973) |
| | UnitAut2 | How much ""freedom"" do you think your manager has to make the kinds of decisions regarding this task that he/she feels would be best for the company? | |
| | UnitAut3 | How much say do you think your group manager has in deciding the goals for this task? | |
| | UnitAut4 | How often does your manager decide in detail how the people he/she supervises should complete this task? | |
| | UnitAut5 | How often does your manager insist that his people follow standard procedures and practices? | |
| | UnitAut6 | How often does your manager discourage people from doing things without first checking with him/her? | |
| Physical Asset Specificity | pas1 | The tools, equipment, and software required to complete this task are similar to those the company uses elsewhere. (reverse coded) | Artz & Brush (2000), Schilling & Steensma (2002), Walker & Poppo (1991), Walker & Weber (1984), Zander & Kogut (1995) |
| | pas2 | This task requires tools, equipment, and software that are unique to the company. | |
| | pas3 | This task requires tools, equipment, and software that are relatively unique to my specific location. | |
| | pas4 | We have made significant investments in tooling, equipment, and software that are particular to this task. | |
| | pas5 | Large parts of our technology are embodied in machines and tools (tooling) that are tailor-made for this task. | |
| | pas6 | The equipment/machinery/software used for this task is common within the industry. (reverse coded) | |
| | pas7 | Few credible substitutes for this equipment/machinery/software are available for completing this task. | |
| Reputation | Rep1 | Firms can easily learn how contractors behaved in their previous relationships with other firms. | Carson, et al. (2003) |
| | Rep2 | If a contractor was less than cooperative in a relationship, it would greatly damage its reputation with other firms. | |
| | Rep3 | In our industry, it is widely known which contractors are the best in terms of performance and collaboration. | |
| | Rep4 | Contractors in our industry watch their reputations closely. | |

## Table 3 (cont.)

### Constructs, Measurement Items, and Supporting Literature

| Construct | Item no. | Item text | Supporting Lit. |
|---|---|---|---|
| Longevity | Long1 | The customers/suppliers involved in this task have worked with our company for years. | Artz & Brush (2000), Poppo & Zenger (1998), Stroh, et al. (1996) |
| | Long2 | Our firm and the customers/suppliers for this task expect our relationship to last a long time. | |
| | Long3 | Our firm and the customers/suppliers for this task have different expectations about the length of our relationship. (reverse coded) | |
| | Long4 | Our firm engages in frequent business dealings with the customers/suppliers involved in this task. | |
| Trust | Trust1 | Our firm would need to assume that the customers/suppliers associated with this task would act dishonestly if given the opportunity. (reverse coded) | Carson, et al. (2003), Steensma & Corley (2000) |
| | Trust2 | Our firm could expect complete honesty from potential customers/suppliers associated with this task. | |
| | Trust3 | The parties expect that conflicts will be resolved fairly, even if no guidelines are given by our formal agreements. | |
| | Trust4 | The parties hold mutual expectations that each will be flexible and responsive to requests by the other, even if not obliged by our formal agreements. | |
| | Trust5 | The parties understand that each will adjust to changing circumstances, even if not bound to change by formal agreements. | |
| Switching Costs | Switch1 | The customer would incur significant expense in moving this task to another location (either another internal unit or external supplier). | Artz & Brush (2000), Mayer (2006), Poppo & Zenger (2002) |
| | Switch2 | It would take a great deal of time for the customer to locate a (new) supplier for this task. | |
| | Switch3 | If the customer were to outsource this task or change suppliers, it would have to spend significant time and effort learning the new supplier's procedures and practices. | |

## Table 4

## Power Analysis

| Parameter | Source | Individual Autonomy | Unit Autonomy | Centrali-zation |
|---|---|---|---|---|
| n | 57 | 57 | 50 | 52 |
| u | 13 | 11 | 10 | 10 |
| v | 43 | 45 | 39 | 41 |
| $R^2$ | 0.25 | 0.25 | 0.25 | 0.25 |
| $f^2$ | 0.33 | 0.33 | 0.33 | 0.33 |
| λ | 19.00 | 19.00 | 16.67 | 17.33 |
| Power at α = .05 | 73.58 | 78.12 | 72.61 | 74.91 |
| Power at α = .10 | 81.93 | 85.66 | 81.35 | 83.31 |

Power calculated for α = .05 using Cohen (1988) as described in Mitchell & Zmud (1996)

Power calculated for α = .10 using http://www.danielsoper.com/statcalc/calc09.aspx

Example power calculation:

Power calculation for Individual Autonomy where $\alpha = 0.05$ and $\lambda = 19.00$:

$$\text{Power} = \text{Power}_L + (1/v_L - 1/v) / (1/v_L - 1/v_U)(\text{Power}_U - \text{Power}_L)$$

At $\lambda = 18$; Power $= 61 + \{(1/20 - 1/57)/(1/20 - 1/60)\} (76 - 61)$

$= 61 + \{0.974\} (15) = 75.61$

At $\lambda = 20$; Power $= 67 + \{(1/20 - 1/57)/(1/20 - 1/60)\} (81 - 67)$

$= 67 + \{0.974\} (14) = 80.63$

Interpolating to $\lambda = 19$

At $\lambda = 19$; Power $= (75.61 + 80.63) / 2 = 78.12$

# Table 5

## Rotated Factor Matrix

| | Factor | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| beh1 | -.107 | -.099 | -.090 | .101 | .052 | -.066 | -.202 | .203 | **.892** | .196 |
| beh2 | .091 | -.028 | .101 | -.115 | .102 | .058 | .230 | .140 | **.614** | .074 |
| beh4 | -.015 | .376 | -.052 | -.068 | -.076 | -.052 | -.241 | .172 | **.624** | -.091 |
| beh5r | .081 | .198 | .206 | -.288 | .052 | .011 | .013 | -.167 | **.577** | -.133 |
| out1 | .428 | -.286 | .056 | **.651** | .135 | .295 | -.140 | .075 | -.270 | -.045 |
| out4 | -.044 | .024 | .127 | **.826** | .067 | .079 | .132 | -.038 | -.113 | .182 |
| out5 | .088 | -.283 | .014 | **.891** | .096 | .059 | -.124 | -.011 | -.072 | -.152 |
| out6 | .165 | -.131 | .177 | **.603** | .234 | .096 | -.096 | -.009 | .053 | -.307 |
| pas1 | .028 | **.715** | -.106 | -.359 | -.181 | -.008 | .015 | .033 | -.097 | -.303 |
| pas2 | -.136 | **.760** | -.168 | .055 | -.081 | -.350 | -.070 | .083 | -.027 | -.134 |
| pas3 | -.282 | **.681** | -.096 | -.195 | -.208 | -.307 | -.063 | .107 | .096 | .024 |
| pas4 | .106 | **.668** | -.002 | -.221 | -.185 | -.234 | -.061 | .144 | -.042 | -.061 |
| pas6 | .166 | **.711** | .050 | .006 | .018 | .034 | -.007 | -.022 | .256 | .057 |
| ITbeh3 | -.057 | -.143 | .085 | .114 | **.791** | .160 | .356 | .030 | .069 | .194 |
| ITbeh4 | .105 | -.137 | .132 | .101 | **.761** | .209 | .239 | -.099 | -.053 | .100 |
| ITbeh5 | .088 | -.113 | .067 | .137 | **.688** | .101 | .093 | .130 | .165 | .055 |
| ITbeh6 | -.095 | -.142 | -.156 | .108 | **.512** | .276 | -.005 | .325 | -.046 | .166 |
| ITout1 | **.693** | .064 | -.070 | .249 | .090 | .130 | .182 | .093 | -.080 | .134 |
| ITout2 | **.719** | .202 | -.053 | .127 | .298 | .241 | .108 | -.191 | .066 | .056 |
| ITout3 | **.914** | -.003 | -.013 | -.026 | -.088 | .016 | .182 | .066 | .162 | .078 |
| ITout4 | **.782** | -.121 | .115 | -.019 | -.066 | .136 | .033 | .137 | -.047 | .094 |
| ITpas1 | .221 | -.100 | -.017 | .247 | .137 | **.869** | .087 | .095 | .035 | .047 |
| ITpas2 | .192 | -.228 | -.044 | .062 | .303 | **.800** | .025 | .090 | .049 | .193 |
| ITpas4 | .101 | -.301 | -.098 | .017 | .156 | **.744** | .077 | -.222 | -.101 | .008 |
| Long1 | .351 | -.004 | .128 | -.048 | .253 | .183 | **.671** | .213 | -.072 | -.262 |
| Long2 | .224 | -.108 | .235 | -.036 | .121 | .016 | **.744** | .007 | -.031 | -.094 |
| Long3 | -.095 | -.017 | .134 | -.104 | .165 | -.069 | **.427** | .079 | -.100 | .232 |
| Long4 | .163 | -.011 | .276 | .056 | .144 | .129 | **.834** | .002 | .060 | .059 |
| Trust1 | .133 | -.205 | **.613** | .004 | .068 | -.017 | .302 | -.202 | .186 | .067 |
| Trust2 | .294 | -.066 | **.746** | -.092 | .385 | -.094 | -.051 | .096 | -.095 | .010 |
| Trust3 | -.118 | -.110 | **.888** | .069 | .153 | -.042 | .210 | -.060 | -.019 | .072 |
| Trust4 | -.021 | .071 | **.806** | .192 | -.127 | .012 | .256 | .097 | .011 | -.042 |
| Trust5 | -.225 | .027 | **.597** | .209 | -.193 | -.039 | .183 | .338 | .155 | -.112 |
| Switch1 | -.061 | .010 | -.072 | .081 | .066 | -.029 | .169 | **.767** | .308 | .227 |
| Switch2 | .083 | .212 | .065 | -.077 | .045 | -.060 | .037 | **.760** | .063 | -.205 |
| Switch3 | .163 | .046 | .081 | -.025 | .082 | .042 | -.014 | **.880** | .013 | -.038 |
| Scale1 | .159 | -.070 | .040 | -.160 | .239 | .139 | -.003 | .000 | -.055 | **.825** |
| Scale2 | .298 | -.214 | -.019 | .072 | .152 | .114 | -.012 | -.095 | .236 | **.733** |

Extraction Method: Principal Axis Factoring. Rotation Method: Varimax with Kaiser Normalization.

Rotation converged in 9 iterations.

## Table 6

## Construct Cronbach's Alphas

| Construct | Alpha |
|---|---|
| Behavioral Information Localization | .724 - .748 |
| Outcome Information Localization | .869 - .871 |
| Physical Asset Specificity (PAS) | .859 - .861 |
| IT Application to Behavioral IL | .833 - .835 |
| IT Application to Outcome IL | .881 - .901 |
| IT Application to PAS | .863 - .864 |
| Source | single item |
| Individual Autonomy | .833 |
| Unit Autonomy | .788 |
| Centralization | .838 |
| Reputation[a] | .865 |
| Longevity | .867 |
| Trust (interorganizational) | .835 - .869 |
| Switching Cost | .843 - .866 |
| Scale | .876 |

[a] The reputation factor was stable only in the centralization analysis

## Table 7

## Descriptive Statistics and Correlation Table – Source

| | | Mean | Std Dev | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Source | 3.32 | 1.017 | 1.000 | | | | | | | | | | | |
| 2 | BEH | 2.4238 | 0.5316 | .016 | 1.000 | | | | | | | | | | |
| 3 | OUT | 2.5982 | 0.6778 | -.338** | -.176 | 1.000 | | | | | | | | | |
| 4 | ITbeh | 1.9878 | 0.4924 | -.097 | .000 | .325* | 1.000 | | | | | | | | |
| 5 | ITout | 2.6209 | 0.6533 | .251 | .004 | .000 | .030 | 1.000 | | | | | | | |
| 6 | BEH_ITbeh | 4.8296 | 1.7157 | -.163 | .000 | -.089 | .000 | .103 | 1.000 | | | | | | |
| 7 | OUT_ITout | 6.8665 | 2.5632 | .200 | -.019 | .000 | -.152 | .000 | -.015 | 1.000 | | | | | |
| 8 | PAS | 1.8662 | 0.4747 | -.113 | -.144 | .235 | .309* | .033 | .008 | -.097 | 1.000 | | | | |
| 9 | LONG | 2.5082 | 0.4320 | .160 | -.070 | .048 | .337** | .284* | -.012 | .079 | .227 | 1.000 | | | |
| 10 | TRUST | 2.6118 | 0.4296 | -.045 | .028 | .160 | .219 | .020 | .147 | .194 | .142 | .442** | 1.000 | | |
| 11 | SWITCH | 3.0574 | 0.6381 | .172 | .228 | -.130 | .042 | .186 | .073 | .125 | -.119 | .135 | .096 | 1.000 | |
| 12 | SCALE | 2.7448 | 0.6173 | .037 | .086 | -.038 | .277* | .251 | -.016 | -.374** | .300* | .115 | .129 | -.061 | 1.000 |
| 13 | TotalEmp | 3.85 | 1.505 | .253 | -.373** | -.180 | .005 | .091 | -.046 | -.165 | .044 | .141 | -.098 | .031 | -.150 |
| 14 | TotalEng | 2.30 | 1.394 | .279* | -.330** | -.231 | -.162 | .139 | .000 | -.259* | .123 | .088 | -.278* | -.095 | .038 |
| 15 | LocEmp | 3.35 | 1.233 | .126 | -.327* | -.120 | .125 | -.039 | .040 | -.180 | .023 | .069 | -.233 | .060 | -.197 |
| 16 | LocEng | 1.97 | 1.104 | .206 | -.386** | -.163 | -.093 | .028 | -.084 | -.252 | .091 | -.039 | -.383** | -.147 | -.052 |
| 17 | lnSales$ | 17.4615 | 2.6733 | .264 | -.401** | -.136 | -.024 | .156 | -.041 | -.123 | -.031 | .207 | .085 | .067 | -.130 |
| 18 | YearsCorp | 9.80 | 6.313 | .081 | .210 | .016 | .393** | .037 | .047 | -.062 | .321* | .143 | .390** | .214 | .315* |
| 19 | YearsEng | 17.12 | 9.896 | -.196 | -.075 | .152 | .151 | -.100 | -.045 | -.221 | .070 | -.314* | .119 | -.065 | .192 |
| 20 | Job | 2.12 | .781 | .012 | .169 | .148 | .164 | .236 | -.016 | -.021 | .117 | .088 | .314* | .147 | .243 |

N= 57
* p<.05, ** p<.01

## Table 7

## Descriptive Statistics and Correlation Table – Source (continued)

| | | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|
| 13 | TotalEmp | 1.000 | | | | | | | |
| 14 | TotalEng | .765** | 1.000 | | | | | | |
| 15 | LocEmp | .869** | .638** | 1.000 | | | | | |
| 16 | LocEng | .701** | .899** | .694** | 1.000 | | | | |
| 17 | lnSales$ | .865** | .719** | .746** | .687** | 1.000 | | | |
| 18 | YearsCorp | .004 | -.120 | .009 | -.232 | -.087 | 1.000 | | |
| 19 | YearsEng | -.161 | -.305* | -.249 | -.255 | -.288* | .333* | 1.000 | |
| 20 | Job | -.127 | -.132 | -.296* | -.302* | -.157 | .618** | .432** | 1.000 |

## Table 8

## Descriptive Statistics and Correlation Table – Individual Autonomy

| | | Mean | Std Dev | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | IndAut | 2.3992 | 0.4526 | 1.000 | | | | | | | | | | | |
| 2 | BEH | 2.3942 | 0.5189 | .342** | 1.000 | | | | | | | | | | |
| 3 | OUT | 2.6414 | 0.6936 | .075 | -.180 | 1.000 | | | | | | | | | |
| 4 | ITbeh | 2.0843 | 0.5543 | .199 | .000 | .319* | 1.000 | | | | | | | | |
| 5 | ITout | 1.6796 | 0.4013 | .028 | -.038 | .000 | .153 | 1.000 | | | | | | | |
| 6 | BEH_ITbeh | 4.9988 | 1.8300 | .167 | .000 | -.106 | .000 | .170 | 1.000 | | | | | | |
| 7 | OUT_ITout | 4.4997 | 1.6474 | -.117 | -.010 | .000 | -.047 | .000 | -.087 | 1.000 | | | | | |
| 8 | PAS | 1.8896 | 0.4814 | -.052 | -.149 | .239 | .285* | .056 | .006 | -.138 | 1.000 | | | | |
| 9 | LONG | 2.4809 | 0.4280 | .163 | -.064 | .045 | .371** | .319* | -.049 | .138 | .230 | 1.000 | | | |
| 10 | TRUST | 2.5770 | 0.4253 | .351** | .030 | .190 | .284* | .032 | .113 | .330* | .141 | .450** | 1.000 | | |
| 11 | SWITCH | 3.0760 | 0.6451 | .181 | .220 | -.129 | -.007 | .093 | .074 | .037 | -.122 | .135 | .070 | 1.000 | |
| 12 | SCALE | 2.6197 | 0.5869 | .312* | .089 | -.036 | .285* | .331* | -.009 | -.239 | .304* | .112 | .081 | -.067 | 1.000 |
| 13 | TotalEmp | 3.85 | 1.505 | -.264* | -.367** | -.180 | -.003 | .174 | -.045 | -.076 | .044 | .143 | -.112 | .035 | -.156 |
| 14 | TotalEng | 2.30 | 1.394 | -.313* | -.324* | -.233 | -.177 | .213 | .016 | -.237 | .124 | .087 | -.300* | -.091 | .031 |
| 15 | LocEmp | 3.35 | 1.233 | -.291* | -.321* | -.118 | .089 | .074 | .075 | -.152 | .023 | .068 | -.240 | .066 | -.203 |
| 16 | LocEng | 1.97 | 1.104 | -.385** | -.380** | -.163 | -.121 | .104 | -.057 | -.249 | .091 | -.039 | -.402** | -.143 | -.058 |
| 17 | lnSales$ | 17.4615 | 2.6733 | -.204 | -.394** | -.137 | -.003 | .244 | -.047 | -.051 | -.031 | .208 | .073 | .073 | -.138 |
| 18 | YearsCorp | 9.89 | 6.430 | .304* | .196 | .022 | .376** | .091 | .093 | -.052 | .316* | .135 | .360** | .198 | .382** |
| 19 | YearsEng | 17.12 | 9.896 | .227 | -.081 | .152 | .116 | -.136 | -.007 | -.229 | .069 | -.311* | .113 | -.069 | .194 |
| 20 | Job | 2.12 | .781 | .390** | .165 | .145 | .174 | .199 | -.017 | -.023 | .117 | .088 | .340** | .144 | .244 |

N= 57

* p<.05, ** p<.01

## Table 8

## Descriptive Statistics and Correlation Table – Individual Autonomy (continued)

| | | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|
| 13 | TotalEmp | 1.000 | | | | | | | |
| 14 | TotalEng | .765** | 1.000 | | | | | | |
| 15 | LocEmp | .869** | .638** | 1.000 | | | | | |
| 16 | LocEng | .701** | .899** | .694** | 1.000 | | | | |
| 17 | lnSales$ | .865** | .719** | .746** | .687** | 1.000 | | | |
| 18 | YearsCorp | -.024 | -.141 | -.008 | -.242 | -.087 | 1.000 | | |
| 19 | YearsEng | -.161 | -.305* | -.249 | -.255 | -.288* | .333* | 1.000 | |
| 20 | Job | -.127 | -.132 | -.296* | -.302* | -.157 | .618** | .432** | 1.000 |

## Table 9

## Descriptive Statistics and Correlation Table – Unit Autonomy

| | | Mean | Std Dev | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | UnitAut | 2.6720 | 0.5011 | 1.000 | | | | | | | | | | | |
| 2 | BEH | 2.5108 | 0.6694 | .149 | 1.000 | | | | | | | | | | |
| 3 | OUT | 2.7027 | 0.7080 | -.120 | -.074 | 1.000 | | | | | | | | | |
| 4 | ITbeh | 1.9434 | 0.4633 | .122 | .000 | .298* | 1.000 | | | | | | | | |
| 5 | ITout | 2.6791 | 0.6527 | .071 | .027 | .000 | .015 | 1.000 | | | | | | | |
| 6 | BEH_ITbeh | 4.9269 | 1.9958 | .023 | .000 | -.084 | .000 | .156 | 1.000 | | | | | | |
| 7 | OUT_ITout | 7.3001 | 2.6760 | -.043 | .066 | .000 | -.204 | .000 | .079 | 1.000 | | | | | |
| 8 | PAS | 1.0540 | 0.9512 | .047 | -.003 | .022 | .307* | .139 | .026 | -.059 | 1.000 | | | | |
| 9 | TRUST | 2.6583 | 0.4417 | .235 | .048 | .156 | .187 | .073 | .277* | .192 | -.069 | 1.000 | | | |
| 10 | SWITCH | 3.3566 | 0.6899 | .370** | .285* | -.124 | .023 | .163 | .211 | .094 | -.024 | .089 | 1.000 | | |
| 11 | SCALE | 2.5347 | 0.5696 | .208 | .152 | -.041 | .295* | .296* | -.058 | -.368** | .255 | .139 | -.057 | 1.000 | |
| 12 | TotalEmp | 3.85 | 1.505 | .015 | -.401** | -.179 | .093 | .124 | -.023 | -.183 | .074 | -.107 | .016 | -.152 | 1.000 |
| 13 | TotalEng | 2.30 | 1.394 | -.216 | -.375** | -.230 | -.052 | .180 | -.060 | -.283* | .098 | -.283* | -.108 | .036 | .765** |
| 14 | LocEmp | 3.35 | 1.233 | -.124 | -.383** | -.117 | .220 | -.025 | .014 | -.191 | .066 | -.243 | .041 | -.199 | .869** |
| 15 | LocEng | 1.97 | 1.104 | -.266* | -.417** | -.162 | .019 | .047 | -.186 | -.270* | .021 | -.387** | -.163 | -.053 | .701** |
| 16 | lnSales$ | 17.4615 | 2.6733 | .010 | -.438** | -.136 | .071 | .204 | -.065 | -.143 | -.009 | .074 | .046 | -.131 | .865** |
| 17 | YearsCorp | 9.80 | 6.313 | .410** | .294* | .014 | .365** | .033 | .179 | -.076 | .253 | .388** | .224 | .314* | .004 |
| 18 | YearsEng | 17.12 | 9.896 | .581** | -.033 | .151 | .138 | -.128 | .007 | -.251 | .002 | .117 | -.051 | .192 | -.161 |
| 19 | Job | 1.88 | .781 | -.419** | -.270* | -.147 | -.134 | -.255 | -.112 | .042 | .054 | -.307* | -.158 | -.243 | .127 |

N= 50

* p<.05, ** p<.01

## Table 9

## Descriptive Statistics and Correlation Table – Unit Autonomy (continued)

| | | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|
| 13 | TotalEng | 1.000 | | | | | | |
| 14 | LocEmp | .638** | 1.000 | | | | | |
| 15 | LocEng | .899** | .694** | 1.000 | | | | |
| 16 | lnSales$ | .719** | .746** | .687** | 1.000 | | | |
| 17 | YearsCorp | -.120 | .009 | -.232 | -.087 | 1.000 | | |
| 18 | YearsEng | -.305* | -.249 | -.255 | -.288* | .333* | 1.000 | |
| 19 | Job | .132 | .296* | .302* | .157 | -.618** | -.432** | 1.000 |

## Table 10

## Descriptive Statistics and Correlation Table – Centralization

| | | Mean | Std Dev | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | CENT | 1.9532 | 0.4982 | 1.000 | | | | | | | | | | | |
| 2 | BEH | 2.4113 | 0.5212 | -.114 | 1.000 | | | | | | | | | | |
| 3 | OUT | 2.6520 | 0.6916 | .413** | -.181 | 1.000 | | | | | | | | | |
| 4 | ITbeh | 2.0247 | 0.4799 | .217 | .000 | .283* | 1.000 | | | | | | | | |
| 5 | ITout | 2.6069 | 0.6502 | -.097 | .012 | .000 | .014 | 1.000 | | | | | | | |
| 6 | BEH_ITbeh | 4.8900 | 1.6821 | .001 | .000 | -.078 | .000 | .128 | 1.000 | | | | | | |
| 7 | OUT_ITout | 6.9705 | 2.6029 | .024 | -.013 | .000 | -.220 | .000 | -.004 | 1.000 | | | | | |
| 8 | PAS | 1.7762 | 0.4877 | .290* | -.096 | .261* | .363** | .108 | .010 | -.063 | 1.000 | | | | |
| 9 | REP | 1.8199 | 0.4847 | .299* | .041 | .301* | .347** | .268* | .204 | -.160 | .466** | 1.000 | | | |
| 10 | LONG | 2.5981 | 0.4446 | .009 | -.057 | .047 | .349** | .272* | .021 | .068 | .241 | .013 | 1.000 | | |
| 11 | TRUST | 2.6025 | 0.4204 | .242 | .042 | .158 | .164 | .010 | .180 | .196 | .170 | .279* | .435** | 1.000 | |
| 12 | SWITCH | 3.0736 | 0.6418 | -.015 | .225 | -.130 | .051 | .189 | .064 | .127 | -.131 | .183 | .137 | .106 | 1.000 |
| 13 | SCALE | 2.6020 | 0.5844 | -.046 | .089 | -.036 | .315* | .252 | -.036 | -.378** | .345** | .336** | .119 | .116 | -.063 |
| 14 | TotalEmp | 3.85 | 1.505 | -.135 | -.368** | -.180 | .046 | .090 | -.038 | -.170 | .007 | -.030 | .140 | -.101 | .031 |
| 15 | TotalEng | 2.30 | 1.394 | -.229 | -.326* | -.229 | -.090 | .139 | -.017 | -.260* | .104 | -.132 | .087 | -.282* | -.096 |
| 16 | LocEmp | 3.35 | 1.233 | -.037 | -.324* | -.119 | .175 | -.042 | .019 | -.182 | -.037 | -.100 | .079 | -.238 | .061 |
| 17 | LocEng | 1.97 | 1.104 | -.159 | -.382** | -.163 | -.024 | .026 | -.113 | -.253 | .066 | -.214 | -.041 | -.387** | -.149 |
| 18 | lnSales$ | 17.4615 | 2.6733 | -.189 | -.393** | -.135 | .017 | .155 | -.044 | -.128 | -.039 | -.086 | .205 | .081 | .067 |
| 19 | YearsCorp | 9.80 | 6.313 | .201 | .214 | .016 | .400** | .036 | .064 | -.060 | .324* | .328* | .148 | .381** | .213 |
| 20 | YearsEng | 17.12 | 9.896 | .211 | -.082 | .151 | .134 | -.100 | -.033 | -.219 | .061 | .312* | -.325* | .114 | -.064 |
| 21 | Job | 2.12 | .781 | .072 | .171 | .150 | .168 | .238 | .013 | -.020 | .130 | .151 | .087 | .305* | .147 |

N= 52

* p<.05, ** p<.01

## Table 10

## Descriptive Statistics and Correlation Table – Centralization (continued)

| | | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
|---|---|---|---|---|---|---|---|---|---|---|
| 13 | SCALE | 1.000 | | | | | | | | |
| 14 | TotalEmp | -.152 | 1.000 | | | | | | | |
| 15 | TotalEng | .035 | .765** | 1.000 | | | | | | |
| 16 | LocEmp | -.199 | .869** | .638** | 1.000 | | | | | |
| 17 | LocEng | -.054 | .701** | .899** | .694** | 1.000 | | | | |
| 18 | lnSales$ | -.132 | .865** | .719** | .746** | .687** | 1.000 | | | |
| 19 | YearsCorp | .314* | .004 | -.120 | .009 | -.232 | -.087 | 1.000 | | |
| 20 | YearsEng | .192 | -.161 | -.305* | -.249 | -.255 | -.288* | .333* | 1.000 | |
| 21 | Job | .243 | -.127 | -.132 | -.296* | -.302* | -.157 | .618** | .432** | 1.000 |

## Table 11
## Hypotheses 1 and 4
## Factors Associated with Sourcing

| | Model 1 | VIF | Model 2 | VIF | Model 3 | VIF |
|---|---|---|---|---|---|---|
| (constant) | 1.005 | | 2.258 | | 2.133 | |
| | (1.651) | | (2.061) | | (2.293) | |
| PAS | -.580 | 1.344 | -.370 | 1.580 | -.396 | 1.593 |
| | (0.355) | | (0.381) | | (0.359) | |
| LONG | .326 | 1.411 | .339 | 1.412 | .070 | 1.733 |
| | (0.391) | | (0.387) | | (0.403) | |
| TRUST | -.143 | 1.760 | -.203 | 1.802 | -.105 | 2.205 |
| | (0.468) | | (0.469) | | (0.487) | |
| SWITCH | .198 | 1.068 | .143 | 1.141 | .051 | 1.209 |
| | (0.223) | | (0.229) | | (0.221) | |
| SCALE | .363 | 1.429 | .309 | 1.457 | .468 | 2.076 |
| | (0.290) | | (.290) | | (0.325) | |
| TotalEng | .080 | 3.321 | .045 | 3.368 | .050 | 3.658 |
| | (0.186) | | (0.185) | | (0.182) | |
| lnSales$ | .068 | 3.232 | .066 | 3.447 | .080 | 3.901 |
| | (0.095) | | (0.097) | | (0.097) | |
| BEH | | | -.026 | 1.425 | -.021 | 1.490 |
| | | | (0.304) | | (0.292) | |
| OUT | | | -.398 † | 1.241 | -.321 | 1.420 |
| | | | (0.237) | | (0.238) | |
| ITbeh | | | | | -.058 | 1.577 |
| | | | | | (0.330) | |
| ITout | | | | | .370 | 1.366 |
| | | | | | (0.230) | |
| BEH_ITbeh | | | | | -.549 | 1.169 |
| | | | | | (0.523) | |
| OUT_ITout | | | | | .695 * | 1.421 |
| | | | | | (0.331) | |
| $R^2$ | .186 | | .238 | | .392 | |
| $\Delta R^2$ | | | .052 | | .154 | |
| F | 1.436 | | 1.456 | | 1.884 † | |
| ΔF | | | 1.426 | | 2.409 † | |

N= 57
† p<.10, * p<.05, ** p<.01

## Table 12

## Hypotheses 2a, 5a, and 5b

## Factors Associated with Individual Autonomy

| | Model 4 | VIF | Model 5 | VIF | Model 6 | VIF |
|---|---|---|---|---|---|---|
| (constant) | 2.094 ** | | 1.006 | | .835 | |
| | (0.587) | | (0.794) | | (0.841) | |
| PAS | -.109 | 1.190 | -.079 | 1.455 | -.065 | 1.496 |
| | (0.134) | | (0.146) | | (0.146) | |
| TotalEng | -.110 † | 2.212 | -.094 | 2.292 | -.109 | 2.647 |
| | (0.062) | | (0.062) | | (0.066) | |
| lnSales | .016 | 2.196 | .031 | 2.346 | .041 | 2.537 |
| | (0.032) | | (0.032) | | (0.033) | |
| YearsCorp | .004 | 1.921 | .001 | 2.104 | -.006 | 2.437 |
| | (0.012) | | (0.012) | | (0.013) | |
| Job | .219 * | 1.756 | .206 * | 1.810 | .241 * | 1.986 |
| | (0.097) | | (0.097) | | (0.100) | |
| BEH | | | .236 † | 1.415 | .249 † | 1.459 |
| | | | (0.123) | | (0.124) | |
| OUT | | | .083 | 1.268 | .073 | 1.414 |
| | | | (0.093) | | (0.098) | |
| ITbeh | | | | | .044 | 1.444 |
| | | | | | (0.118) | |
| ITout | | | | | -.060 | 1.317 |
| | | | | | (0.161) | |
| BEH_ITbeh | | | | | .360 † | 1.106 |
| | | | | | (0.194) | |
| OUT_ITout | | | | | -.187 | 1.118 |
| | | | | | (0.211) | |
| $R^2$ | .251 | | .311 | | ..383 | |
| $\Delta R^2$ | | | .060 | | .072 | |
| F | 3.144 * | | 2.902 * | | 2.315 * | |
| ΔF | | | 1.972 | | 1.198 | |

N= 57
† p<.10, * p<.05, ** p<.01

## Table 13

## Hypotheses 2b, 5c, and 5d

## Factors Associated with Unit Autonomy

| | Model 7 | VIF | Model 8 | VIF | Model 9 | VIF |
|---|---|---|---|---|---|---|
| (constant) | 2.615 ** | | 3.431 ** | | 3.781 ** | |
| | (0.838) | | (1.231) | | (1.347) | |
| PAS | -.085 | 1.191 | -.082 | 1.217 | -.108 | 1.439 |
| | (0.117) | | (0.120) | | (0.135) | |
| TotalEng | -.153 | 2.271 | -.169 | 2.329 | -.172 | 2.586 |
| | (0.105) | | (0.108) | | (0.118) | |
| lnSales | .053 | 2.239 | .046 | 2.379 | .035 | 2.609 |
| | (0.054) | | (0.056) | | (0.061) | |
| YearsCorp | -.002 | 1.982 | -.003 | 2.105 | -.004 | 2.636 |
| | (0.021) | | (0.021) | | (0.025) | |
| Job | -.237 | 1.893 | -.268 | 1.949 | -.246 | 2.308 |
| | (0.169) | | (0.173) | | (0.196) | |
| BEH | | | -.077 | 1.454 | -.089 | 1.558 |
| | | | (0.170) | | (0.183) | |
| OUT | | | -.150 | 1.073 | -.193 | 1.230 |
| | | | (0.145) | | (0.161) | |
| ITbeh | | | | | .166 | 1.449 |
| | | | | | (0.259) | |
| ITout | | | | | .076 | 1.439 |
| | | | | | (0.182) | |
| BEH_ITbeh | | | | | -.115 | 1.122 |
| | | | | | (0.322) | |
| OUT_ITout | | | | | -.054 | 1.165 |
| | | | | | (0.228) | |
| $R^2$ | .123 | | .146 | | .162 | |
| $\Delta R^2$ | | | .022 | | .017 | |
| F | 1.324 | | 1.905 | | .722 | |
| ΔF | | | .581 | | .204 | |

N= 50
† p<.10, * p<.05, ** p<.01

## Table 14
## Hypotheses 3 and 6
## Factors Associated with Centralization

| | Model 10 | VIF | Model 11 | VIF | Model 12 | VIF |
|---|---|---|---|---|---|---|
| (constant) | 1.737 * | | 1.825 † | | 2.176 † | |
| | (0.719) | | (0.911) | | (1.090) | |
| PAS | .425 ** | 1.148 | .297 † | 1.384 | .309 † | 1.535 |
| | (0.149) | | (0.160) | | (0.174) | |
| SCALE | -.074 | 1.252 | -.006 | 1.331 | -.067 | 1.788 |
| | (0.133) | | (0.134) | | (0.160) | |
| TotalEng | -.056 | 2.277 | -.067 | 2.362 | -.058 | 2.620 |
| | (0.071) | | (0.071) | | (0.077) | |
| lnSales | -.013 | 2.293 | -.015 | 2.376 | -.023 | 2.630 |
| | (0.037) | | (0.037) | | (0.040) | |
| BEH | | | -.161 | 1.316 | -.162 | 1.357 |
| | | | (0.136) | | (0.142) | |
| OUT | | | .158 | 1.277 | .118 | 1.445 |
| | | | (0.107) | | (0.118) | |
| ITbeh | | | | | .113 | 1.420 |
| | | | | | (0.161) | |
| ITout | | | | | -.046 | 1.186 |
| | | | | | (0.108) | |
| BEH_ITbeh | | | | | -.030 | 1.045 |
| | | | | | (0.249) | |
| OUT_ITout | | | | | -.097 | 1.357 |
| | | | | | (0.160) | |
| $R^2$ | .186 | | .258 | | .281 | |
| $\Delta R^2$ | | | .072 | | .023 | |
| F | 2.680 * | | 2.609 * | | 1.604 | |
| ΔF | | | 2.195 | | .330 | |

N= 52
† p<.10, * p<.05, ** p<.01

## Table 15
## Hypotheses 1 and 4 (cont.)
## Factors Associated with Sourcing

| | Model 13 | VIF | Model 14 | VIF | Model 15 | VIF |
|---|---|---|---|---|---|---|
| (constant) | 1.005 | | 2.170 | | 2.104 | |
| | (1.651) | | (1.754) | | (1.744) | |
| PAS | -.580 | 1.344 | -.364 | 1.523 | -.403 | 1.525 |
| | (0.355) | | (0.370) | | (0.344) | |
| LONG | .326 | 1.411 | .339 | 1.412 | .107 | 1.513 |
| | (0.391) | | (0.383) | | (0.368) | |
| TRUST | -.143 | 1.760 | -.208 | 1.772 | -.261 | 1.913 |
| | (0.468) | | (0.460) | | (0.444) | |
| SWITCH | .198 | 1.068 | .139 | 1.094 | .028 | 1.152 |
| | (0.223) | | (0.221) | | (0.211) | |
| SCALE | .363 | 1.429 | .307 | 1.447 | .517 | 1.900 |
| | (0.290) | | (0.286) | | (0.304) | |
| TotalEng | .080 | 3.321 | .045 | 3.361 | .032 | 3.363 |
| | (0.186) | | (0.183) | | (0.170) | |
| lnSales$ | .068 | 3.232 | .068 | 3.232 | .095 | 3.370 |
| | (0.095) | | (0.093) | | (0.088) | |
| BEH | | | | | | |
| OUT | | | -.396 † | 1.217 | -.318 | 1.255 |
| | | | (0.232) | | (0.219) | |
| ITbeh | | | | | | |
| ITout | | | | | .333 | 1.294 |
| | | | | | (0.219) | |
| BEH_ITbeh | | | | | | |
| OUT_ITout | | | | | .740 * | 1.358 |
| | | | | | (0.316) | |
| $R^2$ | .186 | | .238 | | .373 | |
| $\Delta R^2$ | | | .052 | | .135 | |
| F | 1.436 | | 1.675 | | 2.434 * | |
| ΔF | | | 2.912 † | | 4.407 * | |

N= 57
† p<.10, * p<.05, ** p<.01

## Table 16

## Hypotheses 2a, 5a, and 5b

## Factors Associated with Individual Autonomy

| | Model 16 | VIF | Model 17 | VIF | Model 18 | VIF |
|---|---|---|---|---|---|---|
| (constant) | 2.094 ** | | 1.217 | | 1.158 | |
| | (0.587) | | (0.757) | | (0.755) | |
| PAS | -.109 | 1.190 | -.037 | 1.304 | -.042 | 1.360 |
| | (0.134) | | (0.138) | | (0.138) | |
| TotalEng | -.110 † | 2.212 | -.104 † | 2.218 | -.103 | 2.365 |
| | (0.062) | | (0.061) | | (0.061) | |
| lnSales | .016 | 2.196 | .031 | 2.346 | .033 | 2.440 |
| | (0.032) | | (0.032) | | (0.032) | |
| YearsCorp | .004 | 1.921 | -.002 | 2.030 | -.007 | 2.209 |
| | (0.012) | | (0.012) | | (0.012) | |
| Job | .219 * | 1.756 | .221 * | 1.756 | .246 * | 1.788 |
| | (0.097) | | (0.095) | | (0.094) | |
| BEH | | | .215 † | 1.362 | .228 † | 1.368 |
| | | | (0.121) | | (0.119) | |
| OUT | | | | | | |
| ITbeh | | | | | .066 | 1.267 |
| | | | | | (0.109) | |
| ITout | | | | | | |
| BEH_ITbeh | | | | | .347 † | 1.038 |
| | | | | | (0.185) | |
| OUT_ITout | | | | | | |
| $R^2$ | .251 | | .299 | | .356 | |
| $\Delta R^2$ | | | .048 | | .058 | |
| F | 3.144 * | | 3.267 ** | | 3.045 ** | |
| ΔF | | | 3.159 † | | 1.966 †† | |

N= 57

† p<.10, * p<.05, ** p<.01

†† p<.10 vs. model 16

## Table 17

## Summary of Results

| Independent variable | Dependent variable | Statistical significance | As predicted |
|---|---|---|---|
| **H1** | | | |
| Outcome IL | Sourcing | † | Yes |
| **H2** | | | |
| Behavioral IL | Individual Autonomy | † | Yes |
| Behavioral IL | Unit Autonomy | Null | No |
| **H3** | | | |
| Behavioral IL | Centralization | Null | No |
| **H4** | | | |
| Outcome IT – Outcome IL | Sourcing | * | Yes |
| **H5** | | | |
| Behavioral IT – Behavioral IL | Individual Autonomy | † | Yes |
| Behavioral IT – Behavioral IL | Unit Autonomy | Null | No |
| **H6** | | | |
| Behavioral IT – Behavioral IL | Centralization | Null | No |

**Table 18**
**Information Constructs Empirical Predictions/Findings**

| Concept | Prior Construct Predictions/Findings | Information Localization Findings |
|---|---|---|
| Information Impactedness | Information impactedness → market failure and internalization (reduced outsourcing)<br>IT → greater outsourcing<br>Does not attempt to explain differences in information regarding internal vs. external governance mechanisms | Outcome IL → reduced outsourcing<br>Behavioral IL → not significant<br>IT application to outcome IL<br>→ no effect for low outcome IL<br>→ greater use of outsourcing for high outcome IL |
| Information Specificity | Distinguishes *inter*organizational specificity & *intra*organizational specificity for environmental information gathering<br>Low *inter*org specificity → outsourcing<br>With high *inter*org specificity:<br>L, M, H levels of *intra*org specificity → centralized, subordinate, and self-gathering respectively<br>IT effectively applied to time specificity & low knowledge specificity cases<br>→ outsourcing or centralization<br>→ unlikely to increase decentralization<br>No empirical test performed | *Inter*organizational and *intra*organizational specificity bear some resemblance to outcome and behavioral IL respectively<br>IT application implications substantially different<br>Low outcome IL → greater outsourcing<br>High behavioral IL → greater autonomy<br>IT application to outcome IL<br>→ no effect for low outcome IL<br>→ greater use of outsourcing for high outcome IL<br>IT application to behavioral IL<br>→ greater autonomy as behavioral IL increases<br>(possible autonomy reduction for low behavioral IL, increase for high behavioral IL) |

**Table 18 (cont.)**
**Information Constructs Empirical Predictions/Findings**

| Concept | Prior Construct Predictions/Findings | Information Localization Findings |
|---|---|---|
| Knowledge Specificity | Hybrid market governance focus<br>BPS → greater joint decision making; DKS → greater quasi integration *and* joint decision making<br>Separate study examined IT use (leading customer's IT system); IT Exploitation use and IT Exploration use → improved competitive performance (with leading customer)<br>Effects mediated by BPS and DKS, with DKS the stronger mediator | Applications of knowledge specificity do not assess outcome-behavioral distinctions<br>Hybrid market governance not assessed (possible avenue for future research)<br>(Extension of current study could provide a more robust test of specificity arguments, leveraging a sample in which applied IT is not a system developed by a powerful common customer of all respondents) |
| Codifiability, Teachability | Organizational capabilities and imitation/transfer focus<br>Codifiability & teachability<br>→ increased probability of early transfer (imitation) or licensing/ joint venture (boundary )<br>Complexity → n.s. regarding imitation; → increased likelihood of organizational (internal) transfer<br>IT effects not examined | Examination of the management of work – does not examine imitation or transfer of innovations or organizational capabilities<br>IL distinction between outcome and behavioral differs substantially<br>IT application implications substantially different<br>→ results detailed under information impactedness and specificity above |
| Sticky Information | Anecdotal evidence shows four responses to stick information re: innovation related problem-solving:<br>(1) Single site holds sticky info → innovation done there<br>(2) Multiple sites involved → activities iterate between them<br>Iteration infeasible → (3) tasks partitioned or (4) investments made to 'unstick' info | Focus on regular production/ operations substantially different<br>No examination of iteration<br>Evidence indicates that IT investments may serve to facilitate partitioning but contradict prediction of "unsticking' information (IT → increased autonomy as IL increases) |

# Appendix 2 – Survey Instrument

**INTRODUCTION & INSTRUCTIONS**

**The survey that follows this cover page is part of a research study that examines the organization and conduct of engineering tasks. If you choose to participate, please complete the entire survey. It will take approximately 15 minutes to complete. If you agree to participate, after you complete the survey you will have the opportunity to enter a drawing for one of the iPod Nanos to be given away. The information provided for the prize drawing will not be associated with your survey responses. The prize drawing will be conducted once the survey is closed to new respondents.**

**The survey will ask a number of questions regarding the characteristics and organization of work for a single task. Please recall the most recent task that you have been involved with that required most of your effort for more than a week (e.g., the design of a single component or subassembly). As you progress through the survey, please consider the characteristics of that same task and how it was organized and carried out. Please respond to each of the questions with the response that is most appropriate for that particular task.**

**I hope you will take a few minutes to complete this survey. Without the assistance of people like you, research such as this could not be conducted. If you consent to participate in this survey please click on the link below. Participation is voluntary and there is no penalty for non-participation. If you have any questions about completing this survey or about participating in this study, you may contact me at jeff.moretz@phd.mccombs.utexas.edu.**

**Strongly Disagree=1** **Disagree=2** **Neither Agree nor Disagree=3** **Agree=4** **Strongly Agree = 5**

| **Behavioral information localization** | **Response Scale** |
|---|---|
| A useful manual describing how to perform this task can be (has been) written. | 1 2 3 4 5 |
| New personnel can easily learn how to complete this task by studying a complete set of manuals. | 1 2 3 4 5 |
| This task frequently requires us to deal with ad hoc, non-routine problems. | 1 2 3 4 5 |
| It is easy to determine if an engineer working on this task is working diligently. | 1 2 3 4 5 |
| Only managers close to this process can determine if engineers are performing their tasks as expected/required. | 1 2 3 4 5 |
| It is easy to monitor the steps employees go through to complete this task. | 1 2 3 4 5 |
| It is difficult for management to monitor specific employee activities involved in completing this task. | 1 2 3 4 5 |

| **Outcome information localization** | **Response Scale** |
|---|---|
| Performance targets for individual employees who carry out this task are clearly specified. | 1 2 3 4 5 |
| It is difficult to specify beforehand all of the elements necessary for the output of this task to meet our needs. | 1 2 3 4 5 |
| Performance in this task is ambiguous – it is difficult to tell how well an individual employee is doing. | 1 2 3 4 5 |
| The amount of the work completed when performing this task can be quantified and measured easily. | 1 2 3 4 5 |
| A brief, inexpensive test or inspection can determine the quality of the output of this task. | 1 2 3 4 5 |
| It is easy to produce comprehensive reports on production that allow accurate assessment of output. | 1 2 3 4 5 |
| Only local (physically proximate) customers or supervisors can assess the quality of work completed. | 1 2 3 4 5 |
| Managers who are not directly involved in this task can easily tell when the work has been completed. | 1 2 3 4 5 |

| **Physical asset specificity** | **Response Scale** |
|---|---|
| The tools, equipment, and software required to complete this task are similar to those the company uses elsewhere. | 1 2 3 4 5 |
| This task requires tools, equipment, and software that are unique to the company. | 1 2 3 4 5 |
| This task requires tools, equipment, and software that are relatively unique to my specific location. | 1 2 3 4 5 |
| We have made significant investments in tooling, equipment, and software that are particular to this task. | 1 2 3 4 5 |
| Large parts of our technology are embodied in machines and tools (tooling) that are tailor-made for this task. | 1 2 3 4 5 |
| The equipment/machinery/software used for this task is common within the industry. | 1 2 3 4 5 |
| Few credible substitutes for this equipment/machinery/software are available for completing this task. | 1 2 3 4 5 |

**Strongly Disagree=1 Disagree=2 Neither Agree nor Disagree=3 Agree=4 Strongly Agree = 5**

| **Workflow and Process Support** | **Response Scale** |
|---|---|
| Our firm uses information technology to identify the appropriate steps for completing this task. | 1 2 3 4 5 |
| IT allows us to create workflow tools for this task that enable participants to follow our standard processes more easily. | 1 2 3 4 5 |
| Our firm uses IT to capture detailed information about specific employee activities in this task. | 1 2 3 4 5 |
| Our firm uses information technology to capture specific information about how employees carry out this task. | 1 2 3 4 5 |
| We use IT to capture specific information about the steps employees go through to complete this task. | 1 2 3 4 5 |
| IT is used to communicate detailed information about the activities of employees involved in this task. | 1 2 3 4 5 |
| Managers use IT to remotely monitor the activities of employees performing this task. | 1 2 3 4 5 |

| **Outcome monitoring application of IT** | **Response Scale** |
|---|---|
| We use IT to create more complete specifications of the output required from this task. | 1 2 3 4 5 |
| We use IT to spell out detailed production requirements to clarify customer and supplier expectations for this task. | 1 2 3 4 5 |
| We use information technology to assess the quantity of work completed in this task. | 1 2 3 4 5 |
| We use information technology to collect specific information about the quality of work done in this task. | 1 2 3 4 5 |
| We use information technology to monitor the output from this task, as it is being produced (in real-time). | 1 2 3 4 5 |
| We use IT to make information about output (from this task) available to the (internal or external) 'customer.' | 1 2 3 4 5 |
| We use IT to receive output information from the (internal or external) supplier that performs this task. | 1 2 3 4 5 |

| **Insourcing/outsourcing** | | | | |
|---|---|---|---|---|
| To what degree is this task done inside or outside of the organization that will use the finished design? | | | | |
| 1 | 2 | 3 | 4 | 5 |
| INSOURCED<br>All aspects of the design of this component (>90%) are insourced (done by the organization's own internal engineers). | Mostly insourced (70-80%), but some work done externally. | MIXED<br>The design of this component is the result of collaboration between supplier engineers and internal (customer) engineers. | Mostly outsourced (70-80%), but some work done internally. | OUTSOURCED<br>All aspects of the design of this component (>90%) are outsourced (done by a supplier). |

| **Centralization/decentralization** | **Response Scale** |
|---|---|
| At what level are the following decisions made for this task?<br>• Mark 1 if the decision is made by the individual engineers (at the component or subassembly level)<br>• Mark 2 if the decision is made by the engineering supervisors (on-site, within the work unit)<br>• Mark 3 if the decision is made by program managers<br>• Mark 4 if the decision is may by division management<br>• Mark 5 if the decision is made above the division level (COO, CEO, etc.) | |
| The goals/objectives for this task | 1 2 3 4 5 |
| The methods used for carrying out this task (details about how the task is done) | 1 2 3 4 5 |
| The sequencing of activities for this task | 1 2 3 4 5 |
| The scheduling of this task | 1 2 3 4 5 |
| Delivery dates and priority of the elements of this task | 1 2 3 4 5 |
| The number of engineers required for this task | 1 2 3 4 5 |
| Allocation of the work among available engineers | 1 2 3 4 5 |
| The machinery or equipment to be used for this task | 1 2 3 4 5 |

| **Individual Autonomy** | **Response Scale** |
|---|---|
| **Strongly Disagree=1 Disagree=2 Neither Agree nor Disagree=3 Agree=4 Strongly Agree = 5** | |
| I am allowed to decide how to go about getting this task done (the methods to use). | 1 2 3 4 5 |
| This task is such that I can decide when to do particular work activities. | 1 2 3 4 5 |
| I have some control over what I am supposed to accomplish in this task (what my supervisor sees as my task objectives). | 1 2 3 4 5 |
| Engineers themselves have significant input in deciding the goals for this task? | 1 2 3 4 5 |
| Management or my supervisor focuses on the attainment of specific targets for this task and allows me considerable discretion in deciding the best way to achieve these targets. | 1 2 3 4 5 |
| For this task, little action is taken here until a supervisor approves a decision. | 1 2 3 4 5 |
| For this task, a person who wants to make his/her own decisions would be quickly discouraged. | 1 2 3 4 5 |
| For this task, even small matters have to be referred to someone higher up for a final decision. | 1 2 3 4 5 |

| **Unit Autonomy** | **Response Scale** |
|---|---|
| **None=1 Little=2 Some=3 Much=4 A Great Deal=5** | |
| How much say do engineering supervisors have in deciding the goals for this task? | 1 2 3 4 5 |
| How much "freedom" do you think your manager has to make the kinds of decisions regarding this task that he/she feels would be best for the company? | 1 2 3 4 5 |
| How much say do you think your group manager has in deciding the goals for this task? | 1 2 3 4 5 |

| **Never=1 Rarely=2 Sometimes=3 Very Often=4 Always=5** | |
|---|---|
| How often does your manager decide in detail how the people he/she supervises should complete this task? | 1 2 3 4 5 |
| How often does your manager insist that his people follow standard procedures and practices? | 1 2 3 4 5 |
| How often does your manager discourage people from doing things without first checking with him/her? | 1 2 3 4 5 |

**Strongly Disagree=1** **Disagree=2** **Neither Agree nor Disagree=3** **Agree=4** **Strongly Agree = 5**

| **Reputation of contractors (who can perform this task)** | **Response Scale** |
|---|---|
| Our firm can easily learn how contractors behaved in their previous relationships with other firms. | 1 2 3 4 5 |
| If a contractor was less than cooperative in our relationship, it would greatly damage its reputation with other firms. | 1 2 3 4 5 |
| In our industry, it is widely known which contractors are the best in terms of performance and collaboration. | 1 2 3 4 5 |
| Contractors in our industry watch their reputations closely. | 1 2 3 4 5 |

| **Longevity of contracting relationship** | **Response Scale** |
|---|---|
| The suppliers involved in this task have worked with our company for years. | 1 2 3 4 5 |
| Our firm and the suppliers for this task expect our relationship to last a long time. | 1 2 3 4 5 |
| Our firm and the suppliers for this task have different expectations about the length of our relationship. | 1 2 3 4 5 |
| Our firm engages in frequent business dealings with the suppliers involved in this task. | 1 2 3 4 5 |

| **Trust** (please respond as if this task were outsourced) | **Response Scale** |
|---|---|
| Our firm would need to assume that the suppliers associated with this task would act dishonestly if given the opportunity. | 1 2 3 4 5 |
| Our firm could expect complete honesty from potential partners and suppliers associated with this task. | 1 2 3 4 5 |
| The parties expect that conflicts will be resolved fairly, even if no guidelines are given by our formal agreements. | 1 2 3 4 5 |
| The parties hold mutual expectations that each will be flexible and responsive to requests by the other, even if not obliged by our formal agreements. | 1 2 3 4 5 |
| The parties understand that each will adjust to changing circumstances, even if not bound to change by formal agreements. | 1 2 3 4 5 |

| **Switching Costs** | **Response Scale** |
|---|---|
| Our company/unit would incur significant expense in moving this task to another location (either another internal unit or external supplier). | 1 2 3 4 5 |
| It would take a great deal of time to locate a (new) supplier for this task. | 1 2 3 4 5 |
| If we were to outsource this task or change suppliers, we would have to spend significant time and effort learning the new supplier's procedures and practices. | 1 2 3 4 5 |

**FIRM CHARACTERISTICS**

In this section, we would like to learn about some characteristics of your firm. Please read the statements on the left hand side of the table, and enter your responses on the right hand side:

| | **1-10** | **11-30** | **31-100** | **101-300** | **301-1000** | **1000+** |
|---|---|---|---|---|---|---|
| Total number of employees in your firm | | | | | | |
| Number of engineering employees in your firm | | | | | | |
| Total number of employees in your location | | | | | | |
| Number of engineering employees in your location | | | | | | |

| | |
|---|---|
| Total sales of your firm (in U.S. dollars) | $ |

**PARTICIPANT PROFILE**

We request the following information to be able to report the profile of the study participants at an aggregate level.

1. How many years have you worked in this corporation? ___ Years

2. How many years have you worked in engineering/design engineering? ___Years

3. Please indicate the level of your current job position (please check one):

   □ Below Design Engineer (please specify title):_____

   □ Design Engineer

   □ Senior Design Engineer

   □ Group Manager or above

# References


Afuah, A. 2001. Dynamic Boundaries of the Firm: Are Firms Better off Being Vertically Integrated in the Face of a Technological Change? ***Academy of Management Journal***, 44: 1209 – 1226.

Afuah, A. 2003. Redefining Firm Boundaries in the Face of the Internet: Are Firms Really Shrinking? ***Academy of Management Review***, 28: 34 – 53.

Aiken, M., & Hage J. 1966. Organizational Alienation: A Comparative Analysis. ***American Sociological Review***, 31: 497 – 507.

Aiken, M., & Hage J. 1968. Organizational Interdependence and Intra – organization structure. ***American Sociological Review***, 33: 912 – 930.

Alchian, A., & Demsetz, H. 1972. Production, Information Costs, and Economic Organization. ***American Economic Review***, 62: 777 – 795.

Amit, R., & Zott, C. 2001. Value Creation in E-business. ***Strategic Management Journal***, 22: 493 – 520.

Andersen, T. J. 2001. Information Technology, Strategic Decision Making Approaches and Organizational Performance in Different Industrial Settings. ***Journal of Strategic Information Systems***, 10: 101 – 119.

Andersen, T. J., & Foss, N. J. 2005. Strategic Opportunity and Economic Performance in Multinational Enterprises: The Role and Effects of Information and Communication Technology. ***Journal of International Management***, 11: 293 – 310.

Andersen, T. J., & Segars, A. H. 2001. The Impact of IT on Decision Structure and Firm Performance: Evidence from the Textile and Apparel Industry. ***Information & Management***, 39: 85 – 100.

Anderson, E. 1985. The Salesperson as Outside Agent or Employee: A transaction cost analysis. ***Marketing Science***, 4: 234 – 254.

Anderson, E., & Schmittlein, D. 1984. Integration of the Sales Force: An Empirical Investigation. ***Rand Journal of Economics***, 15: 385 – 95.

Ansoff, H. I., & Brandenburg, R. G. 1971. A Language for Organizational Design: Part II. ***Management Science***, 17: 717 – 731.

Arrow, K. J. 1975. Vertical Integration and Communication. ***The Bell Journal of Economics***, 6: 173 – 183.

Artz, K. W., & Brush, T. H. 2000. Asset Specificity, Uncertainty and Relational Norms: an Examination of Coordination Costs in Collaborative Strategic Alliances. ***Journal of Economic Behavior & Organization***, 4: 337 – 362.

Auster, E. R. 1989. Task Characteristics as a Bridge between Macro – and Microlevel Research on Salary Inequality between Men and Women. ***Academy of Management Review***, 14: 173 – 193.

Azoulay, P. 2004. Capturing Knowledge within and across Firm Boundaries: Evidence from Clinical Development. ***The American Economic Review***, 94: 1591 – 1612.

Baiman, S., & M. V. Rajan. 1995. The Informational Advantages of Discretionary Bonus Schemes. ***The Accounting Review***. 70: 557 – 579.

Bakos, J. Y., & Nault, B. R. 1997. Ownership and Investment in Electronic Networks. ***Information Systems Research***, 8: 321 – 341.

Becerra – Fernandez, I., & Sabherwal, R. 2001. Organizational Knowledge Management: A Contingency Perspective. ***Journal of Management Information Systems***. 18: 23–55.

Bennis, W. G. 1966. ***Changing Organizations***. New York: McGraw – Hill.

Bergeron, B. P. 2003. **Essentials of Shared Services**. Hoboken, Jew Jersey: Wiley & Sons, Inc.

Berle, A. A., & Means, G. C. 1968. **The Modern Corporation and Private Property**. New York: Harcourt, Brace & World.

Breaugh, J. A. 1985. The Measurement of Work Autonomy. ***Human Relations***, 38, 551 – 570.

Breaugh, J. A. 1989. The Work Autonomy Scales: Additional Validity Evidence. ***Human Relations***, 42: 1033 – 1056.

Breaugh, J. A. 1999. Further Investigation of the Work Autonomy Scales: Two Studies. ***Journal of Business and Psychology***, 13: 357 – 373.

Brews, P. J., & Tucci, C. L. 2004. Exploring the Structural Effects of Internetworking. ***Strategic Management Journal***, 25: 429 – 451.

Brown, C. 1998. Reconceptualizing the Context – Design Issue for the Information Systems Function. ***Organization Science***, 9: 176 – 193.

Brynjolfsson, E. 1994. Information Assets, Technology, and Organization. ***Management Science***, 40: 1645 – 1662.

Brynjolfsson, E., Malone, T. W., Gurbaxani, V., & Kambil, A. 1994. Does Information Technology Lead to Smaller Firms? ***Management Science***, 40: 1628 – 1644.

Campbell, D. J. 1988. Task Complexity: A Review and Analysis. ***Academy of Management Review***, 13: 40 – 52.

Camponovo, G., & Pigneur, Y. 2006. Conceptual Foundations For Designing Information Systems Supporting The Strategic Analysis Of Technology Environments. ***Twenty Seventh International Conference on Information Systems SIG – DSS Workshop***. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.67.1307&rep=rep1&type=pdf

Carson, S. J., Madhok, A., Varman, R., & John, G. 2003. Information Processing Moderators of the Effectiveness of Trust – Based Governance in Interfirm R&D Collaboration. ***Organization Science***, 14: 45 – 56.

Caves, R. E. 2002. Industrial Organization, Corporate Strategy and Structure: a Survey. In D. Faulkner (Ed.), ***Strategy: Critical Perspectives on Business and Management***: 35 – 71. New York: Routledge.

Child, J., & McGrath, R. G. 2001. Organizations Unfettered: Organizational Form in an Information – intensive Economy. ***Academy of Management Journal***, 44: 1135 – 1148.

Choudhury, V., and Sampler, J. L. 1997. Information Specificity and Environmental Scanning: An Economic Perspective, ***MIS Quarterly***, 21: 25 – 53.

Christiaanse, E., & Venkatraman, N. 2002. Beyond Sabre: An Empirical Test of Expertise Exploitation in Electronic Channels. ***MIS Quarterly***, 26: 15 – 38.

Chun, M., & Montealegre, R. 2007. The Problems of Embedded ISs and Embedded Knowledge: Implications for Systems Integration and Knowledge Management. ***Journal of IT Management***. 18: 38 – 64.

Coase, R. 1937. The Nature of the Firm. ***Economica***, 4: 386 – 405.

Cohen, J. 1988. ***Statistical Power Analysis for the Behavioral Sciences***. Second Edition. Hillsdale, NJ: Lawrence Erlbaum Associates.

Cohen, J. 2002. ***Applied Multiple Regression/Correlation Analysis for the Behavioral Sciences***. Mahwah: Lawrence Erlbaum Associates.

Cohen, W. M. & Levinthal, D. A. 1990. Absorptive Capacity: A New Perspective on Learning and Innovation. ***Administrative Science Quarterly***, 35: 128 – 152.

Coleman, J. S. 1984. Introducing Social Structure into Economic Analysis. ***The American Economic Review***, Papers and Proceedings of the Ninety – Sixth Annual Meeting of the American Economic Association, 74: 84 – 88.

Comstock, D. E., & Scott, W. R. 1977. Technology and the Structure of Subunits: Distinguishing Individual and Workgroup Effects. ***Administrative Science Quarterly***, 22: 177 – 202.

Cook, P. 2005. Rational Drug Design, the Knowledge Value Chain and Bioscience Megacentres. ***Cambridge Journal of Economics***, 29: 325 – 341.

Czaja, R., & Blair, J. **Designing Surveys: A Guide to Decisions and Procedures**. Thousand Oaks, CA: Pine Forge Press.

de Leeuw, E. D., How, J., & Dillman, D. (eds.) 2008. **International Handbook of Survey Methodology**. London: Routledge Academic.

Demsetz, H. 1983. The Structure of Ownership and the Theory of the Firm. ***Journal of Law & Economics***, 26: 375 – 390.

Dewan, S., & Min, C. 1997. The Substitution of Information Technology for Other Factors of Production: A Firm Level Analysis. ***Management Science***, 43: 1660 – 1675.

Dewar, R. D., & Simet, D. P., 1981. A Level Specific Prediction of Spans of Control Examining the Effects of Size, Technology, and Specialization. ***Academy of Management Journal***, 24: 5 – 24.

Dewar, R. D., Whetten, D. A., & Boje, D. 1980. An Examination of the Reliability and Validity of the Aiken and Hage Scales of Centralization, Formalization, and Task Routineness. ***Administrative Science Quarterly***, 25: 120 – 128.

Drazin, R., & Van de Ven, A. H. 1985. Alternative Forms of Fit in Contingency Theory. ***Administrative Science Quarterly***, 30: 514 – 539.

Eisenhardt, K. M. 1989. Agency Theory: An Assessment and Review. ***Academy of Management Review***, 14: 57 – 74.

Enriquez, J., Pisano, G., & Bok, G. 2002. In Vivo to in Vitro to in Silico: Coping with Tidal Waves of Data at Biogen. ***Harvard Business School case 9 – 602 – 122***.

Evans, D. S., & Grossman, S. J. 1983. Integration. In D. S. Evans (Ed.), ***Breaking up Bell: Essays on Industrial Organization and Innovation***: 95 – 126. Amsterdam: North-Holland.

Fama, E. 1980. Agency Problems and the Theory of the Firm. ***The Journal of Political Economy***, 88: 288 – 307.

Ferdows, K., Lewis, M.A., & Machuca, J.A.D. 2004. Rapid – fire Fulfillment. ***Harvard Business Review***, 82:104 – 110.

Fisher, J. & Govindarajan, V. 1992. Profit Center Manager Compensation: An Examination of Market, Political and Human Capital Factors. ***Strategic Management Journal***, 13: 205 – 217.

Fulk, J., & DeSanctis, G. 1995. Electronic Communication and Changing Organizational Forms. ***Organization Science***, 6: 337 – 349.

Gibbs, M., Merchant, K. A., Van der Stede, W. A., & Vargus, M. E. 2004. Determinants and Effects of Subjectivity in Incentives. ***The Accounting Review***. 79: 409 – 436

Goodhue, D. L. 1995. Understanding User Evaluations of Information Systems. ***Management Science***, 41: 1827 – 1844.

Goodhue, D. L., & Thompson, R. L. 1995. Task – Technology Fit and Individual Performance. ***MIS Quarterly***, 19: 213 – 236.

Govindarajan, V., & Fisher, J. 1990. Strategy, Control Systems, and Resource Sharing: Effects on Business – Unit Performance. ***Academy of Management Journal***, 33: 259 – 285.

Grandcolas U., Rettie R., & Marusenko K. 2003. Web Survey Bias: Sample or Mode Effect? ***Journal of Marketing Management***, 19: 541 – 561.

Grant, R. M. 1996. Prospering in Dynamically – competitive Environments: Organizational Capability as Knowledge Integration. ***Organization Science***, 7: 375 – 387.

Grimes, A. J., & Klein, S. M. 1973. The Technological Imperative: The Relative Impact of Task Unit, Modal Technology, and Hierarchy on Structure. ***The Academy of Management Journal***, 16: 583 – 597.

Grossman, S. J., & Hart, O. D. 1986. The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration. ***Journal of Political Economy***, 94: 691 – 719.

Guilhon, B. 2004. Markets for Knowledge: Problems, Scope and Economic Implications. ***Economics of Innovation and New Technology***. 13: 165 – 182.

Gurbaxani, V., & Whang, S. 1991. The Impact of Information Systems on Organizations and Markets. ***Communications of the ACM***, 34: 59 – 75.

Hage J., & Aiken, M. 1967. Relationship of Centralization to Other Structural Properties. ***Administrative Science Quarterly***, 12: 72 – 92.

Hage J., & Aiken, M. 1969. Routine Technology, Social Structure, and Organization Goals. ***Administrative Science Quarterly***, 14: 366 – 376.

Hage, J., & Dewar, R. 1973. Elite Values Versus Organizational Structure in Predicting Innovation. ***Administrative Science Quarterly***, 18: 279 – 290

Hair, J. F. Jr., Anderson, R. E., Tatham, R. L., & Black, W. C. 1995. ***Multivariate Data Analysis***, 3rd ed. New York: Macmillan.

Hart, O., & Moore, J. 1990. Property Rights and the Nature of the Firm. ***Journal of Political Economy***, 98: 1119 – 1158.

Hayek, F. 1945. The Use of Knowledge in Society. ***American Economic Review***, 35: 519 – 530.

Helpman, Elhanan, ed. 1998. **General Purpose Technologies and Economic Growth**. Cambridge, MA: MIT Press.

Hickson, D. J., Pugh, D. S., & Pheysey, D. C. 1969. Operations Technology and Organization Structure: An Empirical Reappraisal. ***Administrative Science Quarterly***, 14: 378 – 397.

Hillmer, F. G., & Quinn, J. B. 1995. Strategic Outsourcing. The McKinsey Quarterly, 1: 48 – 70.

Holmström, B., & Roberts, J. 1998. The Boundaries of the Firm Revisited. ***Journal of Economic Perspectives***, 12: 73 – 94.

Hrebiniak, L. G. 1974. Job Technology, Supervision, and Work – Group Structure. ***Administrative Science Quarterly***, 19: 395 – 410.

Huckman, R., & Strick, E. 2005. GlaxoSmithKline: Reorganizing Drug Discovery (A). ***Harvard Business School case 9 – 605 – 075***.

Hülsmann M., & Windt K. 2007. ***Understanding Autonomous Cooperation and Control in Logistics—the Impact on Management, Information and Communication and Material Flow***. New York: Springer.

Ittner, C. D., Larcker D. F., & Meyer. M. W. 2003. Subjectivity and the Weighting of Performance Measures: Evidence from a Balanced Scorecard. ***The Accounting Review***. 78: 725 – 758.

Jacobides, M. G., & Billinger, S. 2006. Designing the Boundaries of the Firm: From "Make, Buy, or Ally" to the Dynamic Benefits of Vertical Architecture. ***Organization Science***, 17: 249 – 261.

Jacobides, M. G., & Winter, S. G. 2005. The Co – evolution of Capabilities and Transaction Costs: Explaining the Institutional Structure of Production. ***Strategic Management Journal***, 26: 395 – 413.

Jaworski, B. J., & Kohli, A. K. 1991. Supervisory Feedback: Alternative Types and Their Impact on Salespeople's Performance and Satisfaction. ***Journal of Marketing Research***, 28: 190 – 201.

Jensen, M. C., & Meckling, W. H. 1976. Theory of the Firm: Managerial Behavior, Agency Costs, and Ownership Structure. ***Journal of Financial Economics***, 3: 305 – 360.

Jensen, M. C., & Meckling, W. H. 1992. Knowledge, Control and Organizational Structure, In Lars Werin and Hans Wijkander (Eds.), ***Current Economics***: 251 – 274. Blackwell, Oxford.

Joinson, A. N. 2001. Self-disclosure in Computer-mediated Communication: The Role of Self-Awareness and Visual Anonymity. ***European Journal of Social Psychology***, 31: 177 – 192.

Jones, G. R. 1987. Organizational – client Transactions and Organizational Governance Structures. ***Academy of Management Journal***, 30: 197 – 218.

Joyce, W. F., McGee, V. E., & Slocum, J. W., 1997. Designing Lateral Organizations: an Analysis of the Benefits, Costs, and Enablers of Nonhierarchical Organizational Forms. ***Decision Sciences***, 28: 1 –25.

Kettinger, W. J., & Grover, V., 1997. The Use of Computer – mediated Communication in an Interorganizational Context. ***Decision Sciences***, 28: 513–555.

Kim, J., & Mahoney, J. T. 2005. Property Rights Theory, Transaction Costs Theory, and Agency Theory: An Organizational Economics Approach to Strategic Management. ***Managerial and Decision Economics***, 26: 223–242.

Kochhar, R. 1996. Explaining Firm Capital Structure: The Role of Agency Theory vs. Transaction Cost Economics. ***Strategic Management Journal***, 17: 713 – 728.

Kogut, B., & Zander, U. 1992. Knowledge of the Firm, Combinative Capabilities, and the Replication of Technology. ***Organization Science***, 3: 383 – 397.

Kraft, M. 1999. An Empirical Investigation of the Antecedents of Sales Force Control Systems. ***Journal of Marketing***, 63: 120 – 134.

Kuhn, A., & Beam, R. D. 1982. **The Logic of Organization**. San Francisco: Jossey – Bass Publishers.

Lance, C. E. 1988. Residual Centering, Exploratory and Confirmatory Moderator Analysis, and Decomposition of Effects in Path Models Containing Interactions. ***Applied Psychological Measurement***, 12(2): 163 – 175.

Leavitt, H. J., & Whisler, T. L. 1958. Management in the 1980's. ***Harvard Business Review***, November – December: 41 – 48.

Laffont, J. J., & Martimort, D. 2002. **The Theory of Incentives: the Principal – Agent Model**. Princeton, NJ: Princeton University Press.

Legner, C., & Schemm, J. 2008. Toward the Inter – organizational Product Information Supply Chain – Evidence from the Retail and Consumer Goods Industries. ***Journal of the Association for Information Systems***. 9: 119 – 150.

Leiblein, M. J., & Miller, D. J. 2003. An Empirical Examination of Transaction – and Firm – level Influences of the Vertical Boundaries of the Firm. ***Strategic Management Journal***, 24: 839 – 859.

Mahoney, J. T. 1992. The Choice of Organizational Form: Vertical Financial Ownership versus Other Methods of Vertical Integration. ***Strategic Management Journal***, 13: 559 – 584.

Malone, T. W., Yates, J., & Benjamin, R. I. 1987. Electronic Markets and Electronic Hierarchies. ***Communications of the ACM***, 30: 484 – 497.

Maness, R. 1996. Incomplete Contracts and the Choice between Vertical Integration and Franchising. ***Journal of Economic Behavior & Organization***, 31: 101 – 115.

Marschak, T. A. 1965. Economic Theories of Organization. In J. G. March (Ed.), ***Handbook of Organizations***: 423 – 450. Chicago: Rand McNally.

Masten, S. E., Meehan, J. W. Jr., & Snyder, E. A. 1989. Vertical Integration in the U.S. Auto Industry: A Note on the Influence of Transaction Specific Assets. ***Journal of Economic Behavior & Organization***, 12: 265 – 273.

Masten, S. E., Meehan, J. W. Jr., & Snyder, E. A. 1991. The Costs of Organization. ***Journal of Law, Economics, & Organization***, 7 (1): 1 – 25.

Masters, J. K., & Miles, G. Predicting the Use of External Labor Arrangements: A Test of the Transaction Costs Perspective. ***Academy of Management Journal***, 45: 431 – 442.

Matthews, R. 1986. The Economics of Institutions and the Sources of Growth. ***The Economic Journal***, 96: 903 – 918.

Mayer, K. J. 2006. Spillovers and Governance: an Analysis of Knowledge and Reputational Spillovers in Information Technology. ***Academy of Management Journal***, 49: 69 – 85.

Mayer, K. J., & Nickerson, J. A. 2005. Antecedents and Performance Implications of Contracting for Knowledge Workers: Evidence from Information Technology Services. ***Organization Science***, 16: 225 – 242.

McKelvey, B. 1982. **Organizational Systematics: Taxonomy, Evolution, Classification**. Berkeley: University of California Press.

Menard, S. 1995. ***Applied Logistic Regression Analysis: Sage University Series on Quantitative Applications in the Social Sciences***. Thousand Oaks, CA: Sage.

Milgrom, P. & Roberts, J. 1990. The Economics of Modern Manufacturing: Technology, Strategy, and Organization. ***American Economic Review***, 80: 511 – 528.

Milgrom, P., & Roberts, J. 1992. **Economics, Organization and Management**. Upper Saddle River, NJ: Prentice Hall.

Miller, D. 1987. The Genesis of Configuration. ***Academy of Management Review***, 12: 686 – 701.

Miller, D., & Dröge, C. 1986. The Relative Determinants of Structure in Small Firms. ***Administrative Science Quarterly***, 31: 539 – 560.

Mitchell, V., & Zmud, R. 1999. The Effects of Coupling IT and Work Process Strategies in Redesign Projects. ***Organization Science***, 10: 424 – 438.

Monteverde, K., & Teece, D. J. 1982. Supplier Switching Costs and Vertical Integration in the Automobile Industry. ***The Bell Journal of Economics***, 13: 206 – 213.

Nachum, L., & Zaheer, S. 2005. The Persistence of Distance: The Impact of Technology on MNE Motivations for Foreign Investment. ***Strategic Management Journal***, 26: 747 – 767.

Nault, B. R. 1997. Mitigating Underinvestment through IT – enabled Organization Form. ***Organization Science***, 8: 223 – 234.

Nault, B. R. 1998. Information Technology and Organization Design: Locating Decisions and Information. ***Management Science***, 44: 1321 – 1335.

Neter, J., Wasserman, W. & Kutner, M. H. 1989. ***Applied Linear Regression Models***. Homewood, IL: Irwin.

Nightingale, P. 2000. Economies of Scale in Experimentation: Knowledge and Technology in Pharmaceutical R&D. ***Industrial and Corporate Change***, 9: 315 – 359.

Nonaka, I. 1994. A Dynamic Theory of Organizational Knowledge Creation. ***Organization Science***, 5: 14 – 37.

Nunnally, J. C. 1978. **Psychometric Theory**. New York: McGraw Hill.

Orlikowski, W. J. 1992. The Duality of Technology: Rethinking the Concept of Technology in Organizations. ***Organization Science***, 3: 398 – 427.

Parmigiani, A. 2007. Why do Firms both Make and Buy? An Investigation of Concurrent Sourcing. ***Strategic Management Journal,*** 28: 285 – 311.

Parmigiani, A. & Mitchell, W. 2009. Complementarity, Capabilities, And The Boundaries Of The Firm: The Impact Of Within – Firm And Inter – Firm Expertise On Concurrent Sourcing Of Complementary Components. ***Strategic Management Journal,*** 30: 1065 – 1091.

Pedersen, M. K., & Larsen, M. H. 2004. Robustness of a Distributed Knowledge Management Model. ***Proceedings of the 37th Annual Hawaii International Conference on System Sciences (HICSS'04)***, 1: pp. 10026a.

Perrow, C. 1972. ***Complex Organizations: A Critical Essay***, Glenview, IL: Scott, Foresman and Company.

Pfeffer, J. 1982. **Organizations and Organization Theory**. Boston: Pitman.

Pilling, B. K., Crosby, L. A., & Jackson, D. W. Jr. 1994. Relational Bonds in Industrial Exchange: An Experimental Test of the Transaction Cost Economic Framework. ***Journal of Business Research***, 30: 237 – 51.

Pinsonneault, A., & Kraemer, K. L. 1997. Middle Management Downsizing: An Empirical Investigation of the Impact of Information Technology. ***Management Science***, 43: 659 – 679.

Poppo, L., & Zenger, T. 1998. Testing Alternative Theories of the Firm: Transaction Cost, Knowledge – Based, and Measurement Explanations for Make – or – Buy Decisions in Information Services. ***Strategic Management Journal***, 19: 853 – 877

Poppo, L., & Zenger, T. 2002. Do Formal Contracts and Relational Governance Function as Substitutes or Complements? ***Strategic Management Journal***, 23: 707 – 725.

Porter, M. E. 1985. **Competitive Advantage: Creating and Sustaining Superior Performance**. New York: Free Press.

Rajan, M. V., & Reichelstein, S. 2006. Subjective Performance Indicators and Discretionary Bonus Pools. ***Journal of Accounting Research***. 44: 585–618.

Richardson, H. A., Vandenberg, R. J., Blum, T. C., & Roman, P. M. 2002. Does Decentralization Make a Difference for the Organization? An Examination of the Boundary Conditions Circumscribing Decentralized Decision – Making and Organizational Financial Performance. ***Journal of Management***, 28: 217 – 244.

Rindfleisch, A., & Heide, J. B. 1997. Transaction Cost Analysis: Past, Present, and Future Applications. ***Journal of Marketing***, 61: 30 – 54.

Rajagopalan, N., & Finkelstein, S. 1992. Effects of Strategic Orientation and Environmental Change on Senior Management Reward Systems. ***Strategic Management Journal***, 13: 127 – 142.

Rao, H., & Nielsen, E. H. 1992. An Ecology of Agency Arrangements: Mortality of Savings and Loan Associations, 1960 – 1987. ***Administrative Science Quarterly***, 37: 448 – 470.

Robey, D., & Boudreau, M. 1999. Accounting for the Contradictory Organizational Consequences of Information Technology: Theoretical Definitions and Methodological Implications. ***Information Systems Research***, 10: 167 – 185.

Ross, S. A. 1973. The Economic Theory of Agency: The Principal's Problem. ***American Economic Review***, 63: 134 – 139.

Roth, K., & O'Donnell, S. 1996. Foreign Subsidiary Compensation Strategy: An Agency Theory Perspective. ***Academy of Management Journal***, 39: 678 – 703.

Sambamurthy, V., & R. W. Zmud. 1999. Arrangements for Information Technology Governance: A Theory of Multiple Contingencies. ***MIS Quarterly***, 23: 261 – 290.

Sampler, J. L. 1998. Redefining Industry Structure for the Information Age. ***Strategic Management Journal***, 19: 343 – 355.

Sampler, J. L., & Short, J. E. 1998. Strategy in Dynamic Information – intensive Environments. ***Journal of Management Studies***, 35: 429 – 436.

Santos, F. M., & Eisenhardt, K. M. 2005. Organization Boundaries and Theories of Organization. ***Organization Science***, 16: 491 – 508.

Santosus, M. 2002. Underwriting Knowledge. ***CIO***. 15: 85 – 93.

Schilling, M. A., & Steensma, H. K. 2002. Disentangling the Theories of Firm Boundaries: A Path Model and Empirical Test. ***Organization Science***, 13: 387 – 401.

Shoichet, B. K. 2004. Virtual Screening of Chemical Libraries. ***Nature***, 432(7019): 862 – 865.

Shelanski, H. A., & Klein, P. G. 1995. Empirical Research in Transaction Cost Economics: A Review and Assessment. ***Journal of Law, Economics & Organization***, 11: 335 – 361.

Shenkar, O., & Li, J. 1999. Knowledge Search in International Cooperative Ventures. ***Organization Science***, 10: 134 – 143.

Simon, H. A. 1951. A Formal Theory of the Employment Relationship. ***Econometrica***, 19: 293 – 305.

Simon, H. A. 1957. **Administrative Behavior: A Study of Decision – making Processes in Administrative Organization**. 2nd ed., New York: Macmillan.

Simon, H. A. 1957. **Models of Man.** New York: John Wiley & Sons. Inc.

Simon, H. A. 1972. Theories of Bounded Rationality. In C. B. McGuire & R. Radner (Eds.), ***Decision and Organization***: 161 – 176. Amsterdam: North – Holland Publishing Company.

Simon, H. A. 1991. Organizations and Markets. ***Journal of Economic Perspectives***, 5: 25 – 44.

Spence, M., & Zeckhauser, R. 1971. Insurance, Information, and Individual Action. ***The American Economic Review***, 61: 380 – 387.

Steensma, H. K., & Corley, K. G. 2000. On the Performance of Technology – Sourcing Partnerships: The Interaction between Partner Interdependence and Technology Attributes, ***Academy of Management Journal***, 43: 1045 – 1067.

Steensma, H. K., & Corley, K. G. 2001. Organizational Context as a Moderator of Theories on Firm Boundaries for Technology Sourcing. ***Academy of Management Journal***, 44: 271 – 291.

Stroh, L. K., Brett, J. M., Baumann, J. P., & Reilly, A. H. Agency Theory and Variable Pay Compensation Strategies. ***Academy of Management Journal***, 39: 751 – 767.

Tanriverdi, H., & Venkatraman, N. 2005. Knowledge Relatedness and the Performance of Multibusiness Firms. ***Strategic Management Journal***, Volume 26: 97 – 119.

Thomas, L. G. 1996. The Two Faces of Competition: Dynamic Resourcefulness and the Hypercompetitive Shift. ***Organization Science***, 7: 221 – 242.

Tushman, M., & Anderson, P. 1986. Technological Discontinuities and Organizational Environments. ***Administrative Science Quarterly***, 31: 439 – 465.

Tushman, M. & Nadler, D. 1978. Information Processing as an Integrating Concept in Organizational Design. ***Academy of Management Review***, 3: 613 – 624.

Vancil, R. 1980. ***Decentralization: Managerial Ambiguity by Design***. New York: Financial Executive Research Foundation.

Varian, H. R. 1995. Pricing Information Goods. In Research Libraries Group, ed., **Scholarship of the New Information Environment Proceedings**: Washington, D.C.: Research Libraries Group.

Venkatraman, N. 1989. The Concept of Fit in Strategy Research: Toward Verbal and Statistical Correspondence. ***Academy of Management Review***. 14: 423 – 444.

von Hippel, E. 1994. "Sticky Information" and the Locus of Problem Solving: Implications for Innovation. ***Management Science***. 40: 429 – 439.

Walker, G., & Poppo, L. 1991. Profit Centers, Single – Source Suppliers and Transaction Costs. ***Administrative Science Quarterly***, 36: 66 – 87.

Walker, G., & Weber, D. 1984. A Transaction Cost Approach to Make – or – Buy Decisions. ***Administrative Science Quarterly***, 29: 373 – 391.

Walker, G., & Weber, D. 1987. Supplier Competition, Uncertainty, and Make-or-Buy Decisions. ***Academy of Management Journal***. 30: 589 – 596.

Warner, Rebecca. 2007. **Applied Statistics: From Bivariate Through Multivariate Techniques**. Los Angeles: Sage Publications, Inc.

Weiss, A. M., & Anderson, E. 1992. Converting from Independent to Employee Salesforces: The Role of Perceived Switching Costs. ***Journal of Marketing Research***, 29: 101 – 115.

Williamson, O. 1971. The Vertical Integration of Production: Market Failure Considerations. ***The American Economic Review***, 61: 112 – 123.

Williamson, O. 1973. Markets and Hierarchies: some Elementary Considerations. ***The American Economic Review***, 63: 316 – 325.

Williamson, O. 1975. **Markets and Hierarchies Analysis and Antitrust Implications: A Study in the Economics of Internal Organization**. New York: Free Press.

Williamson, O. 1979. Transaction-Cost Economics: The Governance of Contractual Relations. ***Journal of Law and Economics***, 22: 233 – 261.

Williamson, O. 1981. The Economics of Organization: The Transaction Cost Approach. ***The American Journal of Sociology***, 87: 548 – 577.

Williamson, O. 1985. **The Economic Institutions of Capitalism**. New York: Free Press.

Williamson, O. 1991. Comparative Economic Organization: The Analysis of Discrete Structural Alternatives. ***Administrative Science Quarterly***, 36: 269 – 296.

Williamson, O. 1996. **The Mechanisms of Governance**, New York: Oxford University Press.

Windt, K., Böse, F., & Philipp, T. 2008. Autonomy in Production Logistics: Identification, Characterisation and Application. ***Robotics and Computer – Integrated Manufacturing***, 24: 572 – 578.

Woolridge, Jeffrey M. 2001. **Econometric Analysis of Cross Section and Panel Data**, Cambridge, MA: MIT Press.

Zahra, S. A., & George, G. 2002. Absorptive Capacity: A Review, Reconceptualization, and Extension. ***Academy of Management Review***, 27: 185 – 203.

Zander, U., & Kogut, B. 1995. Knowledge and the Speed of the Transfer and Imitation of Organizational Capabilities: An Empirical Test. ***Organization Science***, 6: 76 – 92.

Zenger, T. R., & Hesterly, W. S. 1997. The Disaggregation of Corporations: Selective Intervention, High – powered Incentives, and Molecular Units. ***Organization Science***, 8: 209 – 222.

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