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The Choice of Sourcing Mechanisms for Business Processes

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There is unprecedented interest in digitally enabled extended enterprises that enable firms to gain access to specialized skills and capabilities globally. Given this motivation, firms are unbundling their value chain processes and exploring new sourcing mechanisms. With the emergence of world-class skills and capabilities in offshore locations, new sourcing mechanisms have become available beyond traditional domestic insourcing and outsourcing. However, there is little systematic research examining how firms choose sourcing mechanisms for their business processes. This study views the digitally enabled extended enterprise as a complex system of business processes and examines how sourcing choices are made in such enterprises. It builds on the modular systems theory to posit that modularization of business processes and their underlying information technology (IT) support infrastructures are associated with the choice of sourcing mechanisms for the processes. The study tests this proposition in a sample of business process sourcing choices made by 93 medium and large U.S. firms. The results show that firms tend to choose domestic outsourcing for processes that are high in modularity and offshore outsourcing for processes that are low in modularity. Further, when processes can be detached from a firm's IT infrastructure, firms tend to use offshore outsourcing. However, when processes are tightly coupled with underlying IT infrastructure, it may be infeasible to detach processes and execute them in remote locations. Implications for theory and practice are also discussed.

Key words: digitally enabled extended enterprise; outsourcing; offshoring; insourcing; new organizational forms; modular systems theory; process modularity; information technology detachability; transaction cost economics
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1. Introduction

In response to competitive pressures, firms seek to complement and strengthen their internal capabilities by building digitally enabled extended enterprises that tap into specialized skills and capabilities of other firms across the globe (Hagel and Brown 2005). In this context, firms are unbundling their value chain processes and exploring new sourcing mechanisms (Quinn 2005). Advances in global information technology (IT) and telecommunications infrastructures, trends in deregulation and trade liberalization, and the emergence of world-class skills and capabilities in offshore locations (Ethiraj et al. 2005, Prahalad and Krishnan 2004) have opened up new sourcing opportunities beyond traditional domestic insourcing and outsourcing. Along the ownership (insource versus outsource) and location (domestic versus offshore) dimensions, four main types of sourcing mechanisms are available: domestic insourcing, domestic outsourcing, offshore insourcing, and offshore outsourcing.[1] While the outsourcing phenomenon has been well recognized and addressed in the literature, the business process outsourcing and offshoring phenomena are relatively new. We have yet to understand why firms choose different sourcing mechanisms for their business processes. There is considerable heterogeneity in firms'

[1] Hybrid sourcing arrangements such as joint ventures are not examined in this study.

sourcing choices for business processes, but little systematic research explaining the sources of this heterogeneity. This study seeks to advance our understanding of firms' business process sourcing choices by studying determinants of sourcing choices at the individual process level of analysis.

In the digitally enabled extended enterprise, the locus of production shifts away from the boundaries of a single firm toward the nexus of relationships among hundreds or even thousands of firms (Schilling and Steensma 2001). The extended enterprise faces significant coordination challenges in managing the interdependencies (Malone and Crowston 1994) among its business processes and the providers from which those processes are sourced. It also faces transaction challenges arising from opportunistic behavior and incentive misalignment, e.g., moral hazard, cheating, shirking, holdup, holdbacks, and principle-agent conflicts (Hagel and Brown 2005). Because of the sheer number of firms involved and the complexity of interrelationships among them, the use of managerial authority is too cumbersome, expensive, and impractical to resolve the coordination and transaction challenges in an extended enterprise (Hagel and Brown 2005). Modular systems theory posits that such challenges can be partially addressed through the use of modular organizational design principles such as loose coupling among processes, information hiding (or encapsulation) within processes, and compliance with standardized interface and performance specifications (Baldwin and Clark 2006, Langlois 2006). Modular organizational design enables participating firms to maintain the integrity and autonomy of their internal operations while coordinating process interdependencies (Hagel and Brown 2005).

In this study, we posit that the choice of sourcing mechanisms for business processes is associated with modular design characteristics of the processes and their underlying IT infrastructure. Recent research shows that firms and functional units within firms are at different levels of maturity in terms of their modular design capabilities (Ross et al. 2006). Consequently, business processes can exhibit varying levels of modularity with each other and with the underlying IT infrastructure within and across firms. The variance in the modular design characteristics of business processes can explain significant variance in firms' sourcing choices by explaining how process coordination, transaction, and production costs change under the governance of different sourcing mechanisms. We draw on the modular system theory to develop two constructs—process modularity and IT detachability—to capture modular design characteristics of business processes. These constructs reflect the extent to which a business process can be detached from other firm processes and the underlying IT support infrastructure, executed independently elsewhere, and recombined without loss of functionality. In a survey of the business process sourcing choices made by 93 medium and large U.S. firms, we find empirical support for this proposition.

This paper contributes to the growing body of literature on business process sourcing choices. It conceptually develops and empirically validates the idea that modular design of business processes and their underlying IT support infrastructure is associated with the choice of sourcing mechanism for the proc esses. The ideas and constructs developed in this study are likely to foster further research into the design of modular processes and IT architecture in global sourcing capabilities, scalability, agility, flexibility, innovativeness, and ultimately, superior performance and sustained competitive advantages of digitally enabled extended enterprises.

The paper proceeds as follows. Section 2 provides the theoretical foundation for the study. Section 3 develops the process modularity and IT detachability (ITD) constructs and hypothesizes about their associations with the choice of sourcing mechanisms. Section 4 presents methodological details of the empirical study. Section 5 presents the findings. Section 6 concludes the paper with a discussion of the findings and their implications.

2. Theoretical Foundations

According to the modular systems theory, a firm can be viewed as a complex, hierarchically nested system of production (Simon 1962). Each component of the system is, in turn, a subsystem of finer components. The level of analysis chosen determines the identity of the system and its subsystems (Schilling 2000), e.g., the firm; functional units within the firm such as R&D, information systems (IS), and marketing; business processes within those functional units; tasks within the business processes; and so forth. In this study, we focus on the business process level of analysis. A firm has a large number of business processes that interact with each other and the underlying IT infrastructure of the firm (Porter 2001). The firm decides how to divide the required functionality among processes, where to perform the processes, how to achieve communication and coordination among them, and how to put their outcomes together without loss of functionality.

2.1. Modularization of Business Processes

Process modularization is a form of organizational design that creates a high degree of independence or "loose coupling" among business processes (Sanchez and Mahoney 1996). It entails the design of architecture, interfaces, and standards. Architecture specifies which processes are parts of the system and what functionality they perform. Interfaces specify how different process modules fit together and communicate with each other. Standards test conformity to interface specifications and measure module performance relative to other modules (Langlois 2002). The term "loose" does not mean lax: Loosely coupled processes comply with stringent interface and performance specifications (Hagel and Brown 2005).

Modular process design aims to shield processes from each other and make them self-contained. The information required for performing business processes is hidden (encapsulated) inside the processes. Process interfaces define how processes will interact and communicate with each other by specifying inputs and outputs. The interfaces reveal as little information as possible about the inner workings of individual processes (Parnas 1972). To the extent that the inner workings of processes do not affect each other, processes can work autonomously and become plugged in and out of the system quickly.

2.2. Implications of Modular Designs for Coordination, Transaction, and Production Costs

Modular process design has implications for ongoing coordination, transaction, and production costs. Coordination costs arise from the need to manage interdependencies among business processes (Malone and Crowston 1994). Transaction costs arise from the need to manage opportunistic behavior and incentive misalignment problems in the context of relationship-specific assets (Hagel and Brown 2005, Langlois 2006, Williamson 1979). Production costs are costs incurred in performing business processes, e.g., salaries of human resources and costs of other input factors of production. A key objective of organizational design is to minimize these costs. Modular process designs can reduce these costs relative to integrated, tightly coupled process designs.

Coordination costs are reduced via the use of standardized interface and performance specifications rather than the use of managerial authority or hierarchy (Sanchez and Mahoney 1996). To interact and communicate with each other, processes adhere to standardized interface and performance specifications. This serves as a form of *embedded coordination* within the system and reduces the need for continuous exercise of managerial authority (Hagel and Brown 2005).

Transaction costs decline because standardized interfaces enable processes to interact with each other effectively without being integrated and made specific to a relationship (Langlois 2006, Schilling and Steensma 2001). In general, shared standards reduce specificity and provide a form of embedded control that enables a firm to efficiently exchange with multiple partners by reducing search, monitoring, and enforcement costs (Sanchez and Mahoney 1996).

Production costs also decline because modularity makes it feasible to source processes from markets. Since process modularization reduces coordination and transaction costs, the choice between hierarchical (firm) and market forms of governance becomes closer to a toss-up (Augier and Simon 2003). Markets have production cost advantages over hierarchies because of economies of scale, specialization, and other efficiency advantages. Vendors reduce production costs by pooling demand across multiple clients, offering standardized services, and achieving economies of scale and scope (Levina and Ross 2003).

When capable vendors exist in domestic or offshore markets, it is not so important for a firm to execute business processes in-house as it is to define interface and performance specifications that facilitate sourcing of the processes from those vendors (Venkatesan 1992). Rather than handing detailed instructions about internal operations of the processes, firms can give vendors interface and performance specifications and encourage them to design suitable processes. Although some collaboration and exchange of knowledge take place, the underlying knowledge in each process becomes hidden from the perspective of the focal firm (Langlois 2002). Thus, modular process designs can enable firms to tap into specialized resources and capabilities of a globally dispersed network of vendors and source their processes at lower production costs (Hagel and Brown 2005, Sanchez and Mahoney 1996).

2.3. Implications of Modular Designs for Sourcing Choice

Although the market mechanism provides lower production costs, it is not an adequate substitute for effective organizational design (Augier and Simon 2003). To exploit production cost advantages of the market mechanism in domestic or offshore locations, firms first need to apply modular design principles that decompose their tightly coupled value chains into modular, loosely coupled processes and detach them from the underlying IT infrastructure of the firm. The application of such principles also reduces the coordination and transaction costs. Modular process and IT designs can influence sourcing choices by impacting the total cost of coordination, transaction, and production costs (Baldwin and Clark 2006, Hagel and Brown 2005, Langlois 2006, Sanchez and Mahoney 1996, Schilling and Steensma 2001).

In the next section, we develop two new constructs, process modularity and ITD, to assess the extent to which a business process can be detached from other processes and the underlying IT support infrastructure of the firm, executed elsewhere, and recombined without loss of functionality. We explain how and why modularity and the ITD of a process are associated with the choice of sourcing mechanism.

3. Hypotheses

3.1. Process Modularity

We define business process modularity as *the extent to which a business process is loosely coupled, mature, and standardized enough to be separated from a firm's other business processes, executed independently, and recombined without loss of functionality.* A high degree of independence or "loose coupling" with other processes is necessary but not sufficient for process modularity (Baldwin and Clark 1997, Hagel and Brown 2005, Sanchez and Mahoney 1996, Schilling 2000, Simon 1962). If the process is not mature and standardized, when recombined, it can fail to work together with other processes as an integrated whole or exhibit suboptimal performance and lead to loss of functionality (Baldwin and Clark 1997). Maturity ensures that the process is documented, managed, measured, controlled, and continually improved (CMMI 2002). Standardization ensures that the process is compliant with interface and performance specifications (Baldwin and Clark 2006, Langlois 2006). In combination, loose coupling, maturity, and standardization ensure that the process can be detached from other processes, performed autonomously in a different location, and recombined without loss of functionality.

Process modularity has implications for process coordination, transaction, and production costs (Baldwin and Clark 2006, Langlois 2006, Sanchez and Mahoney 1996, Schilling and Steensma 2001). Coordination costs arising from the management of interdependencies among processes (Malone and Crowston 1994) are lower because compliance with standardized interfaces serves as an embedded coordination mechanism among processes. There is minimal need for managerial intervention for coordination purposes (Hagel and Brown 2005). Transaction costs arising from opportunistic behavior or misaligned behaviors are also lower. Because of modularity, processes are not relationship specific. There is minimal interdependence between the firm and vendors (Baldwin and Clark 2006, Langlois 2006, Schilling and Steensma 2001). If a vendor acts opportunistically, it is easy for the firm to detect the problem and switch to an alternative vendor. Production costs associated with modular processes are also lower because modularity allows sourcing from markets. Vendors reduce production costs by offering standardized services to multiple clients and achieving economies of scale and scope (Levina and Ross 2003). Because process modularity reduces the sum of coordination, transaction, and production costs, it is likely to influence the choice of sourcing mechanism.

At high levels of modularity, a firm can source its processes through a globally dispersed network of vendors (Sanchez and Mahoney 1996). The firm has a choice of using domestic or offshore vendors. In recent years, offshore vendors in locations such as India have developed world-class capabilities that are comparable to or even better than those of the domestic vendors in the United States (Ethiraj et al. 2005, Hagel and Brown 2005). In addition, these vendors have been able to reduce production costs by taking advantage of lower labor costs and other input factors of production. Thus, a firm may be tempted to source modular processes from offshore locations. However, prior studies recognize the possibility that domestic vendors can also tap into lower production cost structures by setting up offshore subsidiaries, exploiting the same cost advantages, and eroding the cost advantages of offshore vendors (Ethiraj et al. 2005). A domestic vendor's ability to use this option depends on the modularity level of the process under consideration. If the modularity level is low, coordination and transaction costs entailed in sourcing the process from an offshore subsidiary are likely to increase and overwhelm the production cost advantages. If the modularity level is high, coordination and transaction costs are likely to be lower, thereby reducing the overall cost of sourcing the process from an offshore subsidiary. Most domestic vendors have the scale, scope, managerial talent, and expertise to make this arrangement work seamlessly (Hagel and Brown 2005). Thus, at high levels of process modularity, firms have an incentive to work with those domestic vendors rather than searching, assessing, and managing offshore vendors, and dealing with execution challenges themselves.

At low levels of modularity, a process is immature, nonstandard, and tightly coupled with other processes of the firm. Domestic vendors who seek to exploit economies of scale and scope by standardizing solutions across clients may be reluctant to provide services for such processes because they need to be modularized first. Modularization entails tasks such as assessing existing processes, architecting high-level modular designs for them, and implementing the high-level designs. Assessing existing processes involves evaluating client requirements, couplings and interactions among processes, and performance gaps and improvement opportunities. Architecting high-level modular designs requires aligning processes to strategic goals of the client, decomposing them into internally cohesive modules that have minimal interactions with each other, and defining standardized interface and performance specifications. The implementation involves detailed design, change management, testing, monitoring, and iterations through the earlier stages until client requirements are met. The complexity of these modularization tasks does not align well with standardized service models of domestic vendors. Ross et al. (2006) find that less than a third of firms use domestic outsourcing for modularization tasks. When they do offer such services, domestic vendors charge high premiums because of time and skill intensiveness and the customized nature of the modularization tasks.

In this context, offshore outsourcing vendors provide affordable alternatives (Hagel and Brown 2005). Leading offshore vendors define their value proposition around modularization services. For example, a leading offshore vendor, Infosys, pioneered an outsourcing strategy known as "Modular Global Sourcing" and developed the Global Delivery Model (GDM), which helps enterprises at any maturity level realize the full benefits of global sourcing. According to Infosys, the GDM "applies the fundamental concepts of modularization to business process and IT application and infrastructure services sourcing decision making, implementation, and ongoing management" (Infosys 2007). Wipro, another leading offshore vendor, also emphasizes modularization: "Wipro can assist in development, implementation and support of modular, scalable and global enterprise resource planning (ERP), B2E, B2C, B2B, B2Bi, and E2E solutions catering to the extended enterprise" (Wipro 2007).

The offshore vendors have incentives to undertake process modularization tasks of developed economy firms for market penetration, learning, and capability development purposes (Newman 2000, Uhlenbruck et al. 2003). Although the offshore vendors initially offered comparative cost advantages, over time, they have also developed world-class capabilities in executing complex tasks through repeated interactions with clients in advanced economies and gaining in-depth understanding of their business processes (Ethiraj et al. 2005). Many of the offshore service providers in India are now at Level 4 or 5 in the Capability Maturity Model (CMM), which reflects processes optimized for cost and quality (Prahalad and Krishnan 2004). Furthermore, these offshore vendors have manager-to-staff ratios (1 to 8) that are much higher than those of U.S. vendors (1 to 20) because of wage differentials. Unlike middle managers in U.S. vendors, who play broad-based administrative roles, middle managers in offshore vendors are able to focus on time and skill intensive process improvement activities (Hagel and Brown 2005). Offshore vendors send a few professionals to the client site (e.g., United States) for modularization tasks that require client interactions and change management. But they also strive to complete a high percentage of the work in their home countries (e.g., India) to maintain their cost advantages (Ethiraj et al. 2005). For example, they conduct detailed design, code development, testing, support, integration, and documentation in their home countries (Infosys 2007). Thus the choice of offshore outsourcing becomes more likely for business processes that are low in modularity and exhibit a high need for modularization.

Hypothesis 1 (H1). *The modularity level of a business process is significantly associated with the choice of sourcing mechanism.*

Hypothesis 1A (H1A). *At high levels of process modularity, the choice of domestic outsourcing becomes more likely relative to domestic insourcing.*

Hypothesis 1B (H1B). *At low levels of process modularity, the choice of offshore outsourcing becomes more likely relative to domestic insourcing.*

3.2. IT Detachability

We define the ITD of a business process as *the extent to which the process and its underlying IT infrastructure are loosely coupled to allow separation, independent execution of the process on another IT infrastructure, and recombination without loss of functionality*. Loose coupling can be achieved through standardized IT interfaces that take *arguments* from business processes, call on IT system services to perform desired tasks, and return results. However, few firms architect their IT infrastructures for loose coupling and plug-and-play functionality for business process modules (Ross et al. 2006). In most firms, software code that powers a business process is customized and tightly integrated to underlying data and file structures, operating systems, and hardware (Hagel and Brown 2005). When a business process spans multiple units within the firm or multiple partners across firm boundaries, there is a need to integrate it with multiple, and usually disparate, IT systems. IT professionals are skillful at developing tightly coupled solutions that integrate business processes across multiple disparate IT systems. However, over time, the software code becomes so tightly intertwined and complex that even small changes become time consuming, expensive, and risky. Tight coupling also obstructs business process standardization and modularization efforts (Ross et al. 2006). Although trends such as the emergence of ERP systems, virtualization architectures, and service-oriented architectures (SOA) seek to achieve loose coupling between business processes and IT infrastructures (Hagel and Brown 2005), many firms still use legacy applications that tightly couple business processes and IT.

ITD has implications for the feasibility of separating a process from a firm's IT infrastructure, executing it independently on another IT infrastructure, and recombining it with other processes of the firm without loss of functionality. Consider an inventory management application at a retailer. The retailer developed the application in-house using COBOL and optimized the code to run effectively on its DB2 database, mainframe operating system (OS), and hardware platform. Over time, the retailer added customized code to link the application to IT systems of its suppliers and point-of-sales systems of its stores for automatic ordering and replenishment purposes. The application also contains customized IT-enabled connections to other processes of the firm such as accounting and finance processes. Clearly, this application is tightly coupled to the idiosyncratic IT infrastructure of the retailer. Separating it from the retailer, executing it autonomously on a vendor's IT environment, and recombining it with other processes of the retailer without loss of functionality would incur significant setup costs as well as on-going costs in coordination, transaction, and production. In contrast, consider another retailer that uses a standard SAP platform for implementing its business processes, including the inventory management process. Because of the standardized interfaces provided by SAP, separating the inventory management process from this retailer, executing it on the SAP platform of a vendor, and recombining it with other processes of the retailer is comparatively easier, although it still entails challenges.

At low levels of ITD, software code supporting a business process is tightly integrated with underlying data and file structures, OS, and hardware of a firm. Because of lack of modular IT design, there are no well-defined interfaces specifying how the process exchanges inputs and outputs with IT infrastructure components. The process does not easily lend itself to removal from the IT infrastructure and independent execution on an alternative IT infrastructure. One potential solution is to modularize IT infrastructure touched by the business process. However, modularization of even a single IT infrastructure is difficult and costly because it supports many business processes. Redesigning it for modularity requires the support of many process owners and entails significant investment and implementation risks. Another potential solution is to keep intact IT infrastructure touched by the business process, but to use conversion technologies (e.g., translators, emulators, adaptors, gateways) that translate inputs and outputs of the process to achieve cross-platform compatibility with a vendor's IT infrastructure. But conversion technologies are costly to develop and maintain (Farrell and Saloner 1992). They need to be upgraded whenever there are changes to processes or underlying IT infrastructures. Conversion also reduces performance of business processes dramatically (Messerschmitt and Szyperski 2003).[2] A third potential solution is to have a domestic vendor take over the entire system, including business processes, employees, and the IT infrastructure, and run the system for the firm, perhaps on the firm's premises. The domestic vendor is unlikely to exploit economies of scale and scope with this tightly coupled system as much as it does with modular processes and IT systems. Nevertheless, it has the potential to run the tightly coupled system better than the firm because of its specialized managerial and technical resources and capabilities. Offshore vendors are less likely to offer this option, because taking over and running the systems of an advanced economy client in the client's home country would subject them to the cost structures of the advanced economy and erode the cost advantages they have in their developing economy. They also face visa restrictions and provisions that discourage substitution of domestic labor with low-cost foreign labor (Ethiraj et al. 2005). Thus, domestic outsourcing becomes more likely at low levels of IT detachability.[3]

At high levels of ITD, it is relatively easier to separate the process from the underlying IT infrastructure of the firm. The firm can source the process from any location across the globe (Sanchez and Mahoney 1996), e.g., a domestic vendor, an offshore vendor, or an offshore subsidiary. All else being equal, vendors are more attractive because of their specialized capabilities and production cost advantages. Thus the main choice is between domestic and offshore vendors. Offshore vendors have production cost advantages over domestic vendors because of lower labor costs and input factors. Domestic vendors can exploit the same cost advantages by sending the work to their offshore subsidiaries, or subcontracting it to offshore vendors. However, doing so introduces an additional IT infrastructure between the IT infrastructures of the firm and the end solution provider, i.e., the focal firm connects to domestic vendor's IT infrastructure, which, in turn, connects to IT infrastructure of an offshore subsidiary or vendor. The additional IT infrastructure can create scalability and performance problems and inhibit the firm's ability to recombine the process with its other processes without loss of functionality. While loosely coupled IT connections do not cost a lot to develop, they consume a large amount of computing and net-

[2] Solutions such as the Java Virtual Machine (JVM) promise to address the cross-platform compatibility problem by making applications independent of the underlying IT infrastructures. They promise to run the same application, without modification, on every OS/hardware combination for which the JVM is available. However, they run slower and require much more memory than comparable applications written specifically for a given platform. They are rarely used for complex, enterprise type of software applications (Evans et al. 2006).

[3] A firm can choose to retain ownership of the IT infrastructure and the process, outsource just the human resource needs of the process, and provide the vendor with remote login rights, so that the vendor's human resources can login and execute the process remotely. Such use of domestic or offshore human resource outsourcing without transferring the ownership of the process and or the IT infrastructure is out of the scope of this study. Nevertheless, for such scenarios, our ITD construct and associated arguments are still potentially applicable. To exploit such human resource outsourcing opportunities, a firm needs to architect its IT infrastructure for loose coupling and plug-and-play functionality for business processes (Ross et al. 2006). Loose coupling allows easy partitioning of IT system resources for the process; and prevention of deliberate or accidental security violations or break-ins to other processes and parts of the system. When business processes and IT are tightly coupled, the partition for remote login will be more difficult, costly, and perhaps infeasible. We thank the senior editor, M. S. Krishnan, for bringing this issue to our attention.

work resources (Hagel and Brown 2005). At this time, large amounts of inexpensive computing power cannot be made flexibly available to support loosely coupled IT connections, a problem that inhibits the economic viability and broad-based deployment of SOA (Hagel and Brown 2005). To address this problem, the firm is likely to connect directly to the IT infrastructure of an offshore vendor.

Hypotheis 2 (H2). *The ITD of a business process is significantly associated with the choice of sourcing mechanism.*

Hypotheis 2A (H2A). *At low levels of ITD, the choice of domestic outsourcing becomes more likely relative to domestic insourcing.*

Hypotheis 2B (H2B). *At high levels of ITD, the choice of offshore outsourcing becomes more likely relative to domestic outsourcing.*

4. Methodology

4.1. Sample and Data

We tested our hypotheses using survey data from 93 medium and large U.S. firms. The online supplement presents details of the sampling frame, profiles of responding firms, informants, response rate, types of business processes targeted, and data collection and validation procedures.

4.2. Dependent Variable

The dependent variable is the choice of sourcing mechanism. It is a nominal variable containing four categories: domestic insourcing, domestic outsourcing, offshore insourcing, and offshore outsourcing. We also included an *other* category to capture hybrid sourcing mechanisms or collaborative governance mechanisms such as joint ventures and strategic partnerships. As explained in the online supplement,[4] we excluded 2 out of 93 cases that had marked the *other* category and indicated hybrid sourcing mechanisms.

4.3. Explanatory Variables

Table 1 summarizes constructs, measurement items, and supporting literatures of the explanatory constructs of this study.

[4] An online supplement to this paper is available on the *Information Systems Research* website (http://isr.pubs.informs.org/ecompanion.html).

4.3.1. Independent Variables. *Process modularity (MOD)*. The measures of this construct are grounded in the modular systems theory (Baldwin and Clark 1997, Malhotra et al. 2005, Sanchez and Mahoney 1996, Schilling 2000, Simon 1962) and the literatures on product/process life cycle and maturity (Anderson and Zeithaml 1984, Benner 2002, CMMI 2002, Harter et al. 2000).

ITD. We adopted the measures for this construct from the literature on coupling between IT and work process strategies (Mitchell and Zmud 1999), and loosely versus tightly coupled systems (Orton and Weick 1990).

4.3.2. Control Variables. To rule out major alternative explanations for our findings, we review the sourcing literature and control for factors that are shown to have bearings on the sourcing choice. To minimize potential endogeneity concerns, we also include business process and firm-level controls that are likely to influence both independent and dependent variables of the study.

Process-Level Controls: Business process human capital specificity (*HCS*). Prior research found that firm specificity of knowledge impacts sourcing choices (Subramani and Venkatraman 2003). Thus we control for firm specificity of tacit and explicit knowledge associated with a business process. To capture firm specificity of tacit knowledge, we use the HCS construct and define it as *the extent to which human skills, knowledge and understanding associated with a business process are firm specific and nontransferable to other uses* (Anderson 1985; Anderson and Schmittlein 1984; Williamson 1979, 1985). We adapt previously validated measurement items from Anderson (1985) and Anderson and Schmittlein (1984).

Business process intellectual capital specificity (*ICS*). To capture firm-specificity of explicit knowledge embedded in a process, we use the ICS construct and define it as *the extent to which knowledge embedded in the business process such as operating procedures, routines, and embedded data and information are specific to the firm* (Clemons and Hitt 2004, Stump and Heide 1996, Subramani and Venkatraman 2003). We adapted the measures for this construct from validated measures of asset specificity (Stump and Heide 1996) and codified knowledge and intangible assets (Zander and Kogut 1995).

Table 1 Constructs, Measurement Items, and Supporting Literatures

Constructs and definitions	Items		Supporting literatures
Business process modularity (MOD)[a]	MOD1	Changing this business process does not affect our other processes.	Anderson and Zeithaml (1984), Benner (2002), CMMI (2002), Harter et al. (2000), Baldwin and Clark (1997), Malhotra et al. (2005), Sanchez and Mahoney (1996), Schilling (2000), Simon (1962)
	MOD2	It is very easy to detach this business process from our other processes.	
	MOD3	It is very easy to combine or recombine this business process with other processes.	
	MOD4	We can easily assess the performance of this business process independent of the performance of our other processes.	
	MOD5	This business process has very well-defined interfaces with our other processes.[d]	
	MOD6	The technologies, rules, and procedures of this business process are stable.	
	MOD7	There are many exceptions regarding the rules and procedures of this business process (reverse coded).	
	MOD8	Employees find no ambiguity in executing this business process.	
	MOD9	There is seldom any change to this business process.	
	MOD10	Our managers are frequently involved in resolving process-related issues.[d]	
Business process IT detachability (ITD)[a]	ITD1	The interface between this business process and supporting IT infrastructure is well defined.[d]	Mitchell and Zmud (1999), Orton and Weick (1990)
	ITD2	The supporting IT infrastructure is highly customized to the needs of this business process (reverse coded).	
	ITD3	This business process and the supporting IT infrastructure are tightly coupled (reverse coded).	
	ITD4	This business process can be easily transferred and implemented across IT platforms of outsourcing vendors.[d]	
Business process human capital specificity (HCS)[a]	HCS1	To run this business process effectively, workers have to spend a lot of time and effort learning the ins and outs of our firm.	Anderson (1985), Anderson and Schmittlein (1984)
	HCS2	There is a need for significant firm-specific training for a new employee to effectively execute this business process, even when he or she has general experience in our industry.	
	HCS3	Workers need a deeper understanding of our firm and customers to be effective in executing this business process.	
	HCS4	Effective execution of this business process generally requires tacit knowledge acquired through experience in our firm.	
Business process intellectual capital specificity (ICS)[a]	ICS1	The software and applications used in this business process are specific to our firm.	Zander and Kogut (1995), Stump and Heide (1996)
	ICS2	The procedures and routines used in this business process are specific to our firm.	
	ICS3	The data and information embedded in this business process are proprietary to our firm.	
	ICS4	This business process contains our firm-specific intellectual property (trade secrets, patents, copyrights, etc.).	
	ICS5	This business process is standardized across our industry.[d]	
Business process strategic criticality (SC)[a]	SC1	This business process is valuable to our firm.[d]	Barney (1991)
	SC2	This business process is unique to our firm.	
	SC3	This business process is common among our competitors (reverse coded).	
	SC4	In our industry, there are equally effective alternative ways of doing this business process.[d]	
	SC5	It is very difficult for our competitors to replicate how we do this business process.	
	SC6	It would be very costly for our competitors to imitate this business process.	
Type of process (0: non-IT; 1: IT)	TOP	Coded based on the process name reported by the informants	

Table 1 (cont'd.)

Constructs and definitions	Items		Supporting literatures
Firm's strategic risk (SR)[a]	SR1	Damage to customer relationships	Barki and Rivard (1993), Barki et al. (2001)
	SR2	Loss of financial health	
	SR3	Inferior competitive position	
	SR4	Decrease in market share	
Firm's strategic intent (SI)[b]	SI1	[For the business process selected] Cost reduction intent: Reduce the total cost of executing this process	Ang and Straub (1998), DiRomualdo and Gurbaxani (1998), Quin (1999), Goo et al. (2000)
	SI2	[For the business process selected] Quality improvement intent: Improve the quality of existing service	
	SI3	[For the business process selected] Entry into a new market	
	SI4	[For the business process selected] Access to technologies and skilled personnel	
	SI5	[For the business process selected] Reduce time to market of our products	
Firm's experience in domestic outsourcing[c]	DOE	Your firm's experience with the domestic outsourcing mechanism	Leiblein and Miller (2003)
Firm's experience in offshore outsourcing[c]	OOE	Your firm's experience with the offshore outsourcing mechanism	Leiblein and Miller (2003)
Perceived coordination costs (PCC)[a]	PCC1	[For the business process selected] We have (or expect to have) significant amount of communication between the vendor (offshore subsidiary) and us.	Keller (1994), Ang and Straub (1998)
	PCC2	[For the business process selected] We have (or expect to have) frequent interactions with the vendor (offshore subsidiary) in day-to-day operations of this business process.	
	PCC3	[For the business process selected] We have (or expect to have) constant monitoring of the vendor to ensure smooth execution of this business process.	
Perceived negotiation costs (PNC)[a]	PNC1	[For the business process selected] We have difficulty in reaching agreement with the vendor (offshore subsidiary) when problems arise.	Artz and Brush (2000), Simester and Knez (2002), Gailbraith (1973)
	PNC2	[For the business process selected] We have difficulty in negotiating with the vendor (offshore subsidiary) when there are any changes.	
	PNC3	[For the business process selected] We have difficulty in locating, accessing, and transferring information when needed from the vendor (offshore subsidiary).	

[a]Scale: [1]: Strongly disagree … [4]: Neutral … [7]: Strongly agree.
[b]Scale: [1]: Extremely low … [4]: Moderate … [7]: Extremely high.
[c]Scale: [1]: Very poor … [4]: Good … [7]: Exceptional.
[d]Dropped after item purification process.

Cost reduction and quality improvement intents. Cost reduction and quality improvement are two of the most commonly cited intents in the sourcing choices of firms (Ang and Straub 1998, DiRomualdo and Gurbaxani 1998, Quinn 1999). Thus we control for them.

Business process strategic criticality (*SC*). The transaction cost economics (TCE) and the resource-based view (RBV) of the firm imply that strategically critical processes ought to be kept in-house (domestic insource or offshore insource). Thus we control for SC of the business process under consideration. Drawing from the RBV, we measure strategic criticality of a business process by measuring the extent to which it is valuable to the firm, rare among the firm's competitors, and difficult for competitors to substitute and imitate (Barney 1991).

Types of processes. Our sample contains both IT and non-IT business processes. Because IT outsourcing and offshoring have been in practice significantly longer than business process sourcing, vendors may have reached more maturity in the delivery of IT processes. To account for this effect, we use a dummy variable that takes on a value of 1 for IT processes and 0 otherwise.[5]

[5] As part of our robustness checks, we repeated the analyses using a richer process classification scheme based on Porter's value chain: (a) Supply chain and operations processes; (b) Human resource processes; (c) Financial and Accounting processes; (d) Marketing

Firm-level controls: *Firm's strategic risk* (*SR*). The outsourcing and offshoring initiatives can expose a firm to SRs such as losses in financial health, competitive position, and market share (Barki and Rivard 1993, Barki et al. 2001). Thus we control for those factors.

Firm's strategic intent (*SI*). Firms can use sourcing mechanisms for strategic intents such as entry into new markets, access to technologies and skilled personnel, and reduction of time to market of products (DiRomualdo and Gurbaxani 1998, Goo et al. 2000, Quinn 1999). We use dummy variables to capture and control for firms' strategic intent.

Firm's experience with sourcing mechanisms. Firms that have prior experience with a particular sourcing mechanism may be more likely to adopt that mechanism. We use dummy variables to control for whether a firm has prior experience with domestic outsourcing ($0 = \text{No}$; $1 = \text{Yes}$) and offshore outsourcing ($0 = \text{No}$; $1 = \text{Yes}$).

Perceived coordination and negotiation costs. The theory we use in justifying the nomological links in our hypotheses assumes that process modularity and ITD reduce coordination and transaction costs. To validate these assumptions, we include perceptual measures of coordination costs (Ang and Straub 1998, Keller 1994). We also include perceptual measures of negotiation costs to capture transaction costs arising from relationship specificity of processes (Artz and Brush 2000, Simester and Knez 2002).

4.4. Measurement Properties of Constructs

We eliminated items marked as "dropped" in Table 1 either because they failed to converge on the factor they intended to measure, or they were highly noisy and reduced the overall reliability of the corresponding measurement scale. An item purification process examined the theoretical significance of the items, item-to-total correlations, and contributions of items to scale reliabilities. With the items remaining after these procedures, Cronbach's alpha values of all constructs are above the recommended threshold level of 0.70 (Nunnally 1978). As explained in the online supplement, these findings indicate sufficient reliability, especially for the newly developed constructs. The IT detachability construct had two items remaining after the item purification process. Although two items are fewer than the three-item rule of thumb suggested for established constructs, considering that this is a new construct developed for the first time in this study, and that the two items exhibit an Alpha level of 0.74, the two-item construct satisfies the reliability requirements (Nunnally 1978).

A confirmatory factor analysis provides support for convergent and discriminant validity of the multiitem constructs. Comparison of alternative measurement models also provide support for the dimensionality, and convergent and discriminant validity of the process modularity, and ITD constructs. The details of these procedures are explained in the online supplement.

4.5. Descriptive Statistics and Correlations

Table 2 reports descriptive statistics and correlations among the constructs. In line with our theoretical assumptions, process modularity is negatively associated with coordination costs ($r = -0.375$, $p < 0.01$). It also has a negative association with the relationship specificity of a process as indicated by its negative and significant correlations with process human capital specificity ($r = -0.293$, $p < 0.001$) and process ICS ($r = -0.209$, $p < 0.1$). Because of lower relationship specificity, transaction costs are also likely to be lower as indicated by the negative association between process modularity and negotiation costs ($r = -0.436$, $p < 0.01$). Further, process modularity is negatively associated with strategic criticality of the process ($r = -0.213$, $p < 0.05$). As for ITD, as expected, it has a negative association with coordination costs ($r = -0.280$, $p < 0.05$).

4.6. Model Specification

Our dependent variable, the sourcing choice, has four categories: domestic insourcing, domestic outsourcing, offshore insourcing, offshore outsourcing. To our knowledge, there is no theory arguing for or against the presence of inherent ordering among these categories. If researchers are not certain about whether the choice categories are ordered or not, it is better

and Sales processes; (e) Service processes; and (f) IS processes. We defined (f) IT processes as the base case. All dummies capturing the non-IT process types in a, b, c, d, and e are significant, indicating that there are significant differences in sourcing choices for IT and non-IT processes. Because the results are qualitatively the same, for parsimony, we use the simple classification scheme capturing IT versus non-IT processes.

Table 2 Descriptive Statistics and Correlations

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Business process modularity (MOD)	1.000															
2. Business process IT detachability (ITD)	−0.016	1.000														
3. Business process human capital specificity (HCS)	−0.293**	−0.011	1.000													
4. Business process intellectual capital specificity (ICS)	−0.209†	−0.313**	0.400**	1.000												
5. Intent to reduce cost (0 = No; 1 = Yes)	−0.117	−0.096	−0.117	0.154	1.000											
6. Intent to enter new market (0 = No; 1 = Yes)	0.052	−0.068	0.122	0.151	−0.080	1.000										
7. Intent to access technologies and skilled personnel (0 = No; 1 = Yes)	0.266*	0.006	−0.036	−0.135	0.063	0.109	1.000									
8. Intent to reduce time to market (0 = No; 1 = Yes)	−0.034	−0.053	0.002	0.080	0.035	0.369**	0.311**	1.000								
9. Intent to improve quality (0 = No; 1 = Yes)	0.141	−0.120	−0.202†	−0.173	0.120	0.055	0.411**	0.168	1.000							
10. Strategic criticality of process	−0.213*	−0.157	0.379**	0.422**	0.058	0.247*	0.103	0.141	−0.158	1.000						
11. Strategic risk of the sourcing choice	−0.579**	0.066	0.297**	0.164	0.021	−0.045	−0.244*	0.046	−0.249*	0.122	1.000					
12. Experience in domestic outsourcing (0 = No; 1 = Yes)	0.162	−0.040	−0.077	−0.051	0.057	0.113	−0.009	0.085	−0.111	0.019	−0.022	1.000				
13. Experience in offshore outsourcing (0 = No; 1 = Yes)	0.052	0.007	−0.069	0.167	0.234*	0.079	0.182†	0.034	0.087	0.056	−0.115	0.251*	1.000			
14. Type of process (0 = non-IT; 1 = IT)	−0.127	−0.176	−0.012	0.225*	0.086	−0.131	0.005	0.133	0.005	0.081	0.014	−0.327**	−0.040	1.000		
15. Perceived coordination costs	−0.375**	−0.280*	0.153	0.244*	0.283*	−0.042	−0.052	0.023	0.008	0.204	0.301**	−0.042	0.037	0.206	1.000	
16. Perceived negotiation costs	−0.436**	0.091	0.329**	0.235*	0.015	−0.011	−0.224*	−0.036	−0.315**	0.242*	0.468**	−0.228*	−0.012	0.226*	0.295**	1.000
Number of observations	88	88	88	88	88	88	88	88	88	88	88	88	88	88	81	81
Mean	4.200	4.800	4.190	4.010	0.784	0.250	0.640	0.450	0.640	2.470	2.700	0.680	0.430	0.239	5.680	3.140
Standard deviation	1.210	1.510	1.580	1.730	0.414	0.440	0.480	0.500	0.480	1.360	1.170	0.470	0.500	0.450	1.310	1.450

† $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

to use a model with weaker assumptions, i.e., the unordered multinomial logit (MNLG) model (Leclere 1999). If the true model is unordered, the use of an ordered model can result in biased estimates of probabilities of choice. Vice versa, the loss would be the inefficiency of using incomplete information (Amemiya 1985, Long 1997). Whenever the ordinality of the dependent variable is in doubt, the loss of efficiency in a nominal model is outweighed by avoiding potential bias in an ordered model (Long 1997). Thus, in model specification, we assumed that our dependent variable is unordered. An MNLG specification is appropriate for nominal choice variables whose categories are unordered.[6]

MNLG uses a random utility model that links a vector of explanatory variables to a decision maker's probability of choosing a choice category (Train 2003). Specifically, let U_{ij} be firm i's utility for choosing the sourcing mechanism j, $X_i = \{x_{i1}, \ldots, x_{iK}\}$ be the vector of explanatory variables (including business process characteristics and controls) for firm i, $\beta_j = \{\beta_{j1}, \ldots, \beta_{jK}\}$ be the vector of the corresponding coefficient estimates for sourcing mechanism j, and P_{ij} be firm i's probability of choosing the sourcing mechanism j, where $i = 1, \ldots, N$, and $j = 1, \ldots, J$. In this study, $N = 88$, $J = 4$, and $K = 14$. To identify the model, the set of coefficients for domestic insourcing category ($j = 1$) is restricted to 0 and used as the *base choice* or the *reference choice*. The model estimates $J - 1 = 3$ groups of coefficients for the choice categories other than the reference choice. The coefficients capture the effects of the independent variables on the odds that a firm chooses any choice j ($j = 2, \ldots, J$) relative to the reference choice. In other words,

$$\frac{P_{ij}}{P_{i1}} = \frac{\exp(X_i^T\beta_j)}{1+\sum_{j'=2}^{J}\exp(X_i^T\beta_{j'})}\Bigg/\frac{1}{1+\sum_{j'=2}^{J}\exp(X_i^T\beta_{j'})}$$
$$= \exp(X_i^T\beta_j), \quad \forall\, i = 1, \ldots, N,\ j = 2, \ldots, J. \quad (1)$$

[6] We also empirically tested for the presence of a nested model whereby a firm decides between insourcing and outsourcing first, and between domestic and offshore location next. However, the likelihood ratio test ($\chi^2 = 3.224$, df $= 2$) cannot reject the null hypothesis that the model is not nested (Greene 2000). Further, from an empirical point of view, one needs to consider a nested model if the model does not satisfy the independence of irrelevant alternatives (IIA). A Hausman test indicates that our MNLG model satisfies the IIA assumption.

In MNLG, multicollinearity statistics are not available. For the purpose of testing the presence of potential multicollinearity problems in our data, we introduced coordination cost as the dependent variable and ran an ordinary least squares (OLS) regression. As multicollinearity problems arise from the relationships among the independent variables, if there are multicollinearity problems, this approach should be able to detect them. However, the OLS regression revealed that the variance inflation factor values range from 1.24 to 1.78. Because they are all below the cutoff value of 10, there is no indication of multicollinearity problems in our data.

5. Results

Statistical findings from the MNLG analyses are reported in Table 3. Column [1] presents the likelihood ratio tests for each independent variable in the model. Because there are three nonredundant coefficients associated with each independent variable, testing whether a variable x_k has a significant effect on the choice of sourcing mechanisms requires a test of a null hypothesis that all three coefficients are simultaneously equal to zero H_o: $\beta_{1k} = \beta_{2k} = \beta_{3k} = 0$ (Long 1997). Column [1] of Table 3 presents the chi-square statistic differences in -2 log likelihoods between the full model, which includes all of the variables, and a restricted model, which excludes the variable under consideration. The results of this test indicate whether a variable has a significant effect on the choice of sourcing mechanisms. The coefficients in column [1] show that 10 of the 12 control variables included in this study are significantly associated with the sourcing choice. These findings indicate that we were able to identify and control for other factors that are relevant to the sourcing choice. After controlling for these factors, both process modularity ($\chi^2 = 13.2$, df $= 3$, $p < 0.01$) and ITD ($\chi^2 = 6.484$, df $= 3$, $p < 0.05$) have significant associations with the choice of sourcing mechanism. Thus, H1 and H2 are supported. The model statistics reported at the bottom of Table 3 indicate a good fit with the data. Model chi-square is highly significant ($\chi^2 = 115.07$, df $= 42$, $p < 0.001$). Cox and Snell Pseudo R^2 is 0.731. The model correctly classifies 74% of the sourcing decisions.

Table 3 Results from the MNLG Choice Model of Sourcing Mechanisms

Sourcing category under consideration:	[1]	[2] Domestic outsourcing		[3] Offshore outsourcing		[4a] Offshore insourcing		[4b] Offshore insourcing		[5] Offshore outsourcing	
Reference category:		vs. Domestic insourcing		vs. Domestic insourcing		vs. Domestic insourcing		vs. Domestic insourcing		vs. Domestic outsourcing	
Explanatory variables	Likelihood ratio test χ^2 (df = 3)	Coefficient estimates (standard errors)	(e^{β})	Coefficient estimates (standard errors)	(e^{β})	Coefficient estimates (standard errors)	(e^{β})	Coefficient estimates (standard errors)	(e^{β})	Coefficient estimates (standard errors)	(e^{β})
Intercept	10.819*	−1.949 (4.061)		4.475 (3.699)		−13.121* (6.671)		−12.391** (4.684)		6.424 (4.249)	
Independent variables											
Business process modularity (MOD)	13.200**	0.896† (0.544)	2.449	−0.841† (0.527)	0.431	0.709 (0.648)	2.033	0.807† (0.495)	2.241	−1.737** (0.617)	0.176
Business process IT detachability (ITD)	6.484*	−0.751* (0.417)	0.472	0.218 (0.313)	1.244	0.197 (0.402)	1.218	0.252 (0.368)	1.287	0.969* (0.439)	2.635
Control Variables											
Business process human capital specificity (HCS)	21.902***	−1.396** (0.536)	0.248	−0.250 (0.327)	0.779	1.153* (0.562)	3.167	0.927* (0.463)	2.527	1.146* (0.531)	3.146
Business process intellectual capital specificity (ICS)	7.468*	0.924* (0.400)	2.520	0.191 (0.363)	1.210	0.241 (0.489)	1.273	0.371 (0.359)	1.449	−0.734* (0.402)	0.480
Intent to reduce cost (0= No; 1 = Yes)	15.910***	−1.134 (1.216)	0.322	3.703** (1.494)	40.562	2.885* (1.656)	17.909	2.494* (1.344)	12.110	4.837** (1.747)	126.043
Intent to improve quality (0 = No; 1 = Yes)	2.756	−0.205 (1.264)	0.815	−1.284 (1.048)	0.277	−1.904† (1.417)	0.149	−1.636† (1.169)	0.195	−1.079 (1.206)	0.340
Intent to enter new market (0 = No; 1 = Yes)	15.640***	−5.093** (1.839)	0.006	−2.163* (1.188)	0.115	1.036 (1.662)	2.819	— —	—	2.929† (1.779)	18.714
Intent to access technologies and skilled personnel (0 = No; 1 = Yes)	13.788**	2.902* (1.452)	18.217	−1.772† (1.119)	0.170	0.294 (1.597)	1.342	— —	—	−4.675** (1.563)	0.009
Intent to reduce time to market (0 = No; 1 = Yes)	12.441**	4.184** (1.622)	65.600	1.701† (1.071)	5.479	−1.183 (1.877)	0.306	— —	—	−2.483† (1.563)	0.084
Strategic criticality of process	1.682	0.446 (0.488)	1.562	0.265 (0.372)	1.303	−0.133 (0.510)	0.876	— —	—	−0.181 (0.483)	0.834
Strategic risk of the sourcing choice	11.938**	0.569 (0.481)	1.767	−1.169* (0.529)	0.311	0.093 (0.629)	1.097	— —	—	−1.739** (0.622)	0.176
Experience in domestic outsourcing (0 = No; 1 = Yes)	7.458*	−0.071 (1.194)	0.932	−2.373* (1.062)	0.093	−0.391 (1.320)	0.677	— —	—	−2.302* (1.217)	0.100
Experience in offshore outsourcing (0 = No; 1 = Yes)	24.891***	−2.109† (1.347)	0.121	3.457** (1.160)	31.735	1.382 (1.359)	3.982	— —	—	5.566*** (1.530)	261.402
Type of process (0 = non-IT; 1 = IT)	24.158***	−7.224*** (2.197)	0.001	−0.662 (1.021)	0.516	0.843 (1.392)	2.323	— —	—	6.562** (2.113)	707.880
Model statistics											
Log likelihood		−57.833									
χ^2(df = 42)		115.070***									
Cox and Snell Pseudo R^2		0.730									
% of correctly classified observations		73.9%									
Number of observations		88									

Notes. $N = 88$. Domestic insourcing ($n = 23$); domestic outsourcing ($n = 26$); offshore insourcing ($n = 9$); offshore outsourcing ($n = 30$).
† $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

In testing subhypotheses H1A, H1B, H2A, and H2B, we examine statistical significance of coefficient estimates and odds effects given by the MNLG analyses in Table 3. These statistics indicate how business process characteristics are associated with the odds of selection of a sourcing mechanism relative to a reference case. We also examine how a change of one standard deviation (σ) in process modularity and ITD is respectively associated with probabilities of selection of the four sourcing mechanisms when all other variables in the choice model are fixed at their mean values. The results of this marginal effects analysis are presented in Figures 1(a) and 1(b). Horizontal axes of the figures show three levels (Mean $-\ \sigma$, Mean, Mean $+\ \sigma$) of the process characteristic under consideration. The vertical axes show the probabilities of selection of the sourcing mechanisms. As the patterns in these figures show, one standard deviation change in process modularity or ITD is associated with marked changes in the probabilities of the selection of the four sourcing mechanisms.

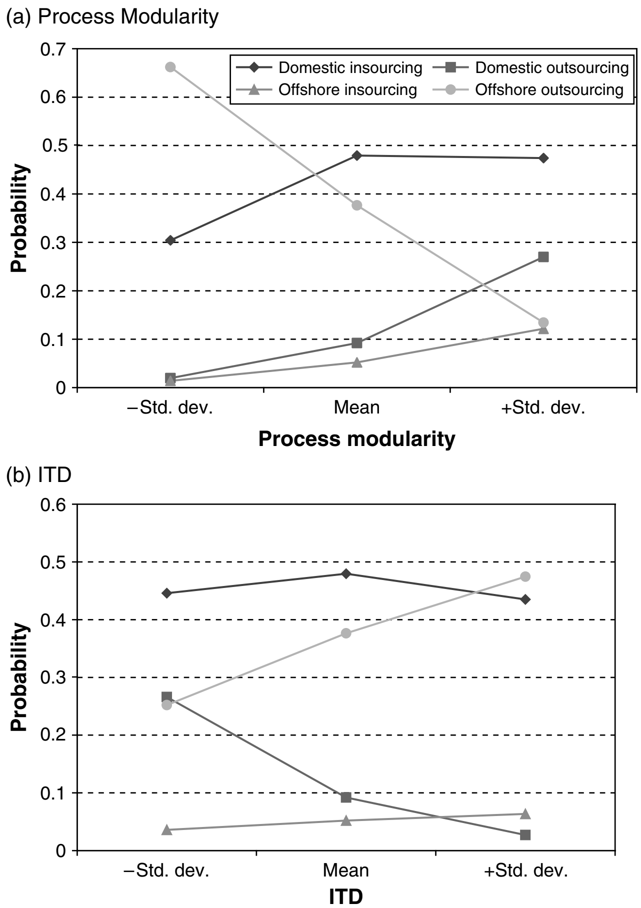
In columns [2], [3], [4a], and [4b] of Table 3, the reference case is domestic insourcing. Because the offshore insourcing cell has only 9 data points and we have 14 variables in the model, there is a possibility that the coefficient estimates in [4a] may not be stable. To check the stability of those estimates, we lowered the number of explanatory variables from 14 to 6 for the offshore insource cell and retained the full 14 variables for the other 3 cells. This implies that the offshore insourcing choice will have a utility function with fewer variables, i.e., the K in Equation (1) will change from 14 to 6 for offshore insourcing, but it will remain 14 for the other choices. The rudimentary MNLG procedures available in SPSS and STATA do not allow us to implement this change. Thus we turned to the LIMDEP statistical package, which offers the programming tools necessary for implementing the new model specification. The results are presented in column [4b] of Table 3. A comparison across [4a] and [4b] indicates that the parameter estimates are qualitatively the same for five of the six constructs. The only discrepancy is in the process modularity construct, which becomes significant in the reduced variable model, a discrepancy that is in favor of our theoretical arguments. These results indicate that the low sample size in offshore insource cell does not pose any major threats to the validity of our findings.[7]

Parameter estimates given in columns [2] through [4] of Table 3 are sufficient for comparing any other pair of the four sourcing mechanisms. For example, in comparing the choice between offshore outsourcing and domestic outsourcing, one can use the coefficients in columns [2] and [3]. However, changing the reference case to domestic outsourcing would make this comparison easier, as shown in column [5].

As Figure 1(a) shows, at the mean levels of all variables in the choice model, domestic insourcing is the most probable choice. When *process modularity increases* one standard deviation above its mean, the most notable changes are the decline in the probability of offshore outsourcing and the increase in the probability of domestic outsourcing. The odds effects values and coefficient estimates given in the pairwise comparisons in columns [2] and [3] of Table 3 indicate that process modularity is positively associated with the odds that a firm chooses domestic outsourcing relative to domestic insourcing (Odds effect $= 2.449$; Beta $= 0.896$, $p < 0.10$), and negatively associated with the odds that a firm chooses offshore outsourcing relative to domestic insourcing (Odds effect $= 0.431$; Beta $= -0.841$, $p < 0.10$). When *process modularity declines* by one standard deviation below its mean, the most notable changes are the increase in the probability of offshore outsourcing and the decline in the probability of domestic insourcing. As shown in columns [3] and [5] of Table 3, process modularity has significant negative associations with a firm's odds of choosing offshore outsourcing relative to domestic insourcing (Odds effect $=$ 0.431; Beta $= -0.841$, $p < 0.10$), and the odds of choosing offshore outsourcing relative to domestic outsourcing (Odds effect $= 0.176$; Beta $= -1.737$, $p <$ 0.01). Declines in modularity levels are associated with increased likelihoods of the selection of offshore

[7] As a further robustness check, we deleted the offshore insourcing cell and assumed that there are only three sourcing mechanisms rather than four. The main finding of the study remained qualitatively the same: business process characteristics significantly impact the choice of sourcing mechanisms. The findings from these robustness checks increase our confidence that the low sample size ($N = 9$) in the offshore insource cell does not pose a threat to the validity of our thesis and findings.

Figure 1 Impact of Process Characteristics on the Probability of Selection of Sourcing Mechanisms



outsourcing relative to domestic insourcing and offshore outsourcing relative to domestic outsourcing. Collectively, these findings provide support for H1A and H1B.

As the analysis in Figure 1(b) shows, at the mean levels of all variables in the choice model, domestic insourcing is the most probable choice. When *IT detachability* increases from low levels (one standard deviation below the mean) to high levels (one standard deviation above the mean), the most notable changes are the increase in the probability of offshore outsourcing and the decline in the probability of domestic outsourcing. The pairwise comparison in column [5] of Table 3 indicates that firms are much more likely to choose offshore outsourcing than domestic outsourcing when ITD goes up (Odds effect = 2.635; Beta = 0.969, $p < 0.05$). As column [2] shows, ITD has a significant negative association with a firm's odds of choosing domestic outsourcing relative to domestic insourcing (Odds effect = 0.472; Beta = −0.751, $p < 0.05$). Declines in ITD levels are associated with increasing probability of selection of domestic outsourcing relative to domestic insourcing. Collectively, these findings provide support for H2A and H2B.

6. Discussion and Conclusion

This study examines how the modular design characteristics of business processes and their underlying IT support infrastructures are associated with sourcing choices of firms. Historically, business processes have been tightly coupled, optimized for specific needs and contexts of businesses and industries, and supported with customized IT solutions (Ross et al. 2006). Although tightly coupled business processes and IT systems can perform well, they face challenges in scalability, flexibility, agility, and innovation needs of firms (Ethiraj and Levinthal 2004, Hagel and Brown 2005, Sanchez and Mahoney 1996, Schilling and Steensma 2001). To address these limitations, firms increasingly seek to build digitally enabled extended enterprises that rely on modular business process and IT infrastructures (Ross et al. 2006). We theoretically motivated two process design characteristics—process modularity and ITD—from the modular systems theory and empirically showed that they are associated with the choice of sourcing mechanisms in digitally enabled extended enterprises.

6.1. Limitations

It is important to recognize the limitations of this study before discussing the broader implications of the findings. First, this was a cross-sectional study conducted at a relatively early stage of the global business process sourcing phenomenon. We focused only on the choice of sourcing mechanism based on design characteristics of the processes. We did not theorize about or test outcomes such as scalability, agility, flexibility, or performance. The popular press reports that a majority of business process outsourcing initiatives have not achieved the objectives that motivated them (Wighton 2005). While it is tempting to assess outcomes at the individual process level of analysis, in a complex system that contains thousands of business processes, outcomes are likely to materialize at the system level rather than the individual process level, and therefore require study at a higher level of analysis. Second, we assumed that firms lacking internal capabilities for process modularization are likely to outsource the modularization tasks. Prior studies empirically validated the assumption that firms choose outsourcing to compensate for a lack of, or weakness in, internal capabilities (Mayer and Salomon 2006). Our explanations and findings are consistent with this assumption. Nevertheless, explicit measurement of the modularization capabilities of firms and vendors would help further validate this assumption.

Third, building on earlier studies, we assumed that domestic vendors can tap into lower production cost structures of offshore locations by setting up subsidiaries and erode the cost advantages of offshore vendors (Ethiraj et al. 2005), especially when process modularity levels are high. However, our study lacked measures to validate whether, and to what extent, this assumption holds. Fourth, our sample size ($N = 93$) allowed us to examine only the main effects of independent and control variables. While process modularity and ITD may have interesting interactions with our process- and firm-level controls, the sample size was not sufficient to detect the interaction effects in this study. The low sample size in the offshore insourcing cell also inhibited our ability to test hypotheses involving the choice of offshore insourcing. Future studies having access to larger sample sizes can address these limitations. Fifth, the initial conceptualizations and measurement schemes developed in this study for the process modularity and ITD constructs can potentially be useful in understanding not just the global sourcing phenomenon, but also broader questions in digitally enabled extended enterprises. We believe that there is room to conceptualize and validate the dimensionality of these constructs more comprehensively. For example, modular design of an IT infrastructure can be captured at multiple layers such as application, OS, hardware, and communications.

Finally, we conceptually analyzed how process modularity and ITD are associated with coordination, transaction, and production costs, and how these costs, in turn, are associated with the probability of selecting sourcing mechanisms. We explicitly measured coordination and negotiation costs and showed that independent variables are associated with them in predicted ways. We also measured a firm's *intent to reduce cost* in sourcing decisions and showed that the cost reduction intent is associated with the choice of offshore sourcing mechanisms. However, we were not able to include these cost measures as mediators between our independent and dependent variables, because MNLG choice models do not allow the modeling of mediators.

6.2. Implications for Research

Notwithstanding, these limitations, the findings of this study have important implications. Through modular business process and IT designs, firms can unbundle their value chain processes, decouple them from the underlying IT support infrastructure, and make sourcing decisions that best fit the characteristics of business processes. Tight coupling of business processes and IT is negatively associated with a firm's ability to detach its processes from each other and from IT. This may leave the firm with no choice but to use a uniform sourcing mechanism for all business processes. Our findings imply that the firm may forego opportunities to exploit low-cost, high-quality capabilities in offshore locations because tight coupling among business processes and with IT may make it infeasible or too costly to separate a business process from the firm and source it from offshore locations.

TCE, the predominant theory informing firms' governance choices, may suggest that a process that is low in modularity be retained in-house. Tight coupling, low maturity, and a low standardization level would make the process relationship specific, and hence increase the contractual hazards and total costs (coordination, transaction, and production) entailed in sourcing it from domestic or offshore vendors (Langlois 2006, Schilling and Steensma 2001). However, in the face of competition, firms that retain such processes in-house can face even greater SRs such as limiting their scalability, flexibility, agility, and innovativeness, and foregoing opportunities such as accessing complementary capabilities of other firms, reducing costs, and improving performance. The fact that processes rank low in modularity indicate that those firms may lack internal capabilities for modularization. Recent research shows that when firms lack internal capabilities, they turn to outsourcing despite the possibility of contractual hazards implied by the TCE (Mayer and Salomon 2006). In our sample, firms whose business processes rank low in modularity turn to offshore vendors, presumably because of their low-cost, high-quality process modularization capabilities. By tapping into the modularization capabilities of offshore vendors, U.S. firms may be seeking to achieve process modularization, which would not otherwise be possible because of lack or weakness of such capabilities internally. The use of offshore vendors for process modularization may also be associated with lower SR. In our sample, there is a significant negative correlation between process modularity and perceived SR of a firm ($r = -0.579$, $p < 0.001$).

There is increasing evidence that offshore vendors have developed technical and managerial capabilities that are on par with or superior to those of domestic vendors in the United States, through repeated interactions with developed economy clients (Ethiraj et al. 2005). Not surprisingly, our results show that firms prefer offshore outsourcing for business processes that rank low in modularity and exhibit a high need for modularization. From an evolutionary perspective, offshore vendors in emerging economies have strong motivations to learn from clients in advanced economies (Newman 2000, Uhlenbruck et al. 2003), understand their business and industry contexts, and develop capabilities that will position themselves not just as low-cost producers but also as providers of world-class capabilities. For example, Infosys of India pioneered the *modular global sourcing* strategy and positioned itself as a leading designer and provider of modular business processes and IT infrastructure services.

At higher levels of process modularity, firms are likely to choose domestic outsourcing. Process modularity enables domestic vendors to use standardized services and exploit significant economies of scale and scope across a large number of customers. When the existing scale and scope of the operations of domestic vendors are not sufficient to reduce costs to the cost levels of offshore vendors, domestic vendors have the option to source modular processes from their offshore subsidiaries. Because modularity is negatively associated with coordination and transaction costs, second-level sourcing from offshore locations becomes feasible for modular processes and enables domestic vendors to match the lower costs of offshore vendors. Thus, for modular processes, firms can choose domestic vendors and benefit from cost levels as low as those of the offshore vendors without having to search for, evaluate, and manage the offshore vendors themselves.

Our findings also show that the ITD level of a business process is associated with the sourcing choice. Processes that are tightly coupled to their underlying IT infrastructures are too difficult and costly to detach from the firm for independent execution on the IT infrastructures of providers elsewhere. We find that a low level of ITD is negatively associated with a firm's ability to use offshore outsourcing vendors regardless of the cost and capability benefits they may offer. Thus it is misleading to assume that the emergence of low-cost IT infrastructures and capable providers across the globe would uniformly enable the offshoring of all business processes. Most firms have tightly coupled business processes and IT. Rearchitecting them for modularity is costly and fraught with implementation difficulties because of the organizational inertia created by tight coupling (Ross et al. 2006). Thus the advantages achieved by offshoring business processes that are high in IT detachability are not easy to imitate by competitors whose business processes and IT systems are tightly coupled.

Because of complementarities between business processes and IT, it is logical to modularize process and IT infrastructures at the same time. However, the lack of a significant correlation between process modularity and ITD implies that, at this time, modularization efforts may be evolving independently in a relatively ad hoc and exploratory manner. Most large IT outsourcing vendors also offer business process outsourcing services and seek to win both businesses from firms simultaneously. However, firms face major hurdles in the simultaneous modularization of their processes and IT infrastructures. First, the existing systems of tightly coupled business and IT infrastructures create significant inertia. Replacing them with modular, loosely coupled infrastructures amounts to radical change and entails major implementation risks. Thus, most firms prefer to adopt incremental approaches to managing the change process (Ross et al. 2006). Second, most large firms are tied up with previously signed long-term IT outsourcing contracts. It would be very costly for them to start with the modularization of their IT infrastructure before the expiration of those contracts. Third, in firms that have decentralized governance arrangements, autonomous business units may pursue business process or IT modularization efforts independent of the efforts of other business units or the central IT unit. Nevertheless, firms that are able to coordinate the modularization of their business processes and IT infrastructures are likely to achieve the benefits of digitally enabled extended enterprises sooner.

6.3. Implications for Practice

Overall, our findings imply that business and IT managers can add value to their firms by developing an enterprise architecture that contains well-defined modules and interfaces among business processes and between business processes and IT. That is, modular IT infrastructure and business processes can provide firms with digital options (Sambamurthy et al. 2003). Modularity multiplies organizational design options through configuration and reconfiguration of independent modules (Baldwin and Clark 2000). Managers can innovate at the architectural level and respond rapidly to changing market conditions by changing the configurations of business processes in search of local efficiency and competitive advantage (Baldwin and Clark 2006). Vendors can innovate at the module level through localized adaptation within self-contained modules (Baldwin and Clark 2000). Firms can gain the option to source modular business processes from low-cost, world-class providers wherever they may reside.

While competitors can observe and imitate individual business processes (e.g., by sourcing them from the same vendors), because of the sheer number of processes and the interconnections and interdependencies among them, it is not a trivial matter to observe and imitate the whole (Simon 1962). The whole is greater than the sum of the parts. What is strategic is not the individual business processes per se, but the overall architecture of the digitally enabled extended enterprise. Global sourcing capabilities, scalability, agility, flexibility, innovativeness, superior performance, and sustained competitive advantages can result from an organizational capability that can unbundle value chain activities into modular business processes, select appropriate sourcing mechanisms for them, and continuously update the enterprise architecture for combining and recombining the processes in ways that minimize the overall coordination, transaction, and production costs of the firm.

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