THE AMBIVALENT EFFECT OF COMPLEXITY ON FIRM PERFORMANCE:

A STUDY OF THE GLOBAL SERVICE PROVIDER INDUSTRY

Abstract: While complexity has usually been associated with more detrimental organizational consequences, there are also arguments suggesting that complexity may function as a source of competitiveness. In this paper, we investigate specific circumstances that yield opposing effects of complexity on firm performance. Embedded in rich data on the global service provider industry, we find that configuration complexity is negatively related to performance (due to rising coordination costs), while task complexity is positively related to performance (due to information asymmetry). Besides explicating specific performance contingencies of complexity, these results suggest that treating complexity as an aggregate variable may lead to underspecified and even incorrect, conclusions, and that a finer-grained understanding of its effects is crucial.

Keywords: Configuration complexity, task complexity, performance, interdependencies, global service provider industry.

INTRODUCTION

Much research has successfully demonstrated the negative consequences of complexity. Complexity deriving from a large number of interdependencies increases coordination costs (Thompson, 1967; Rawley, 2010; Zhou, 2011) and jeopardizes the organizational ability to process information (Ethiraj and Levinthal, 2004; Tushman and Nadler, 1978), which, in turn, increases the likelihood of decision errors and eventually lowers performance (Levinthal, 1997; March and Simon, 1958). At the same time, research has pointed to the potential benefits of complexity. For example, complexity is argued to be more difficult for competitors to imitate (Hart, 1995; Singh, 1997; Rueda-Manzanares et al., 2007) which, in turn, may promote rent appropriation and eventually competitiveness particularly in ill-structured and dynamic environments (Lippman and Rumelt, 1982).

This paper addresses this ambivalence by questioning the contingencies that predict the effects of complexity on firm performance. Specifically, we disentangle the complexity construct by studying how configuration complexity (i.e. degree of organizational differentiation and interdependence between sub-units) and task complexity (i.e. degree of interdependence between sub-tasks as well as means-ends ambiguity) yield opposite effects on firm performance. We do this in the empirical context of the highly competitive and dynamic global service provider industry which offers a range of both simple and highly complex services, from call centers, tech support, IT, finance and accounting, to engineering, design, and analytical services, distributed to a variety of globally dispersed clients (Athreye, 2005; Sako, 2006; Dossani and Kenney, 2007). Service providers range from small, highly specialized vendors to full-service providers with globally distributed operations (Couto et al., 2008; Govindarajan and Ramamurti, 2011). This range of services and firm profiles, along with the continuous struggle of providers to innovate and generate margins within a highly competitive and fast-changing client market makes the global service provider industry a very appropriate context to study the relation between complexity and performance.

Adopting an interdependency view of complexity (Simon, 1962; Thompson, 1969; Zhou, 2011), we hypothesize and measure two opposing effects on performance. On the one hand, we argue that configuration complexity is negatively related to performance (measured by vendor margins). A high number of inter-unit interdependencies increases coordination costs, which, unless appropriately managed, have a *negative* effect on vendor performance (Rawley, 2010; Zhou, 2011). On the other hand, we argue that task complexity is positively related to performance. Task complexity resulting from intra-unit interdependencies promotes information asymmetry vis-à-vis clients which enables service providers to appropriate higher economic rents and thus generate a *positive* effect on margins (Nayyar, 1993). To further elucidate the difference between these two types of complexity, but also to understand the mechanisms firms may employ to mitigate the consequences of complexity, we discuss two moderating variables: process commoditization, which lowers coordination costs (Davenport, 2005), and hence moderates the effect of configuration complexity; and client-specific investments, which lower information asymmetry (Dyer and Singh, 1998), and hence moderate the effect of task complexity on performance.

With this paper we are making three major contributions. First, our results indicate that treating complexity as an aggregate variable may lead to underspecified, and even incorrect, conclusions. For example, rather than automatically associating complexity with organizational inefficiencies, inertia and lack of response capacity (e.g., Moldoveanu and Bauer, 2004; Park and Ungson, 2001; Robson *et al.*, 2008), we argue for a more fine-grained understanding of the effects of complexity that takes into account underlying mechanisms (i.e., coordination costs as well as information asymmetry) that impact performance. Second, we specify mechanisms that may mitigate the effect of complexity on performance. Whereas prior research has emphasized the need to match information processing complexity with appropriate organizational designs and capabilities (Ethiraj and Levinthal, 2004; Galbraith, 1973; Russo and Harrison, 2005), we show how process properties may be equally important factors to manage complexity in an organizational domain (cf. Thompson, 1967). Third, our findings contribute to a more nuanced understanding of performance conditions in the service provider industry by applying a provider's perspective rather than a client's perspective. We stress how key tensions facing providers, such as the need to increase the scope and distribution of operations and to focus on more complex tasks to generate revenue opportunities, may have opposite and unintended consequences for performance (see also Sako, 2006; Couto et al., 2008).

We continue with a review of the complexity construct and the particular conditions in the global service provider industry. We then formulate and test hypotheses on the effect of configuration and task complexity on performance, as well as the moderating effects of process commoditization and client-specific investments. We finally discuss our findings as well as broader implications for research on complexity and performance in general, and the service provider industry in particular.

THEORY AND HYPOTHESES

The complexity construct in organizational research

Much work has been devoted to investigate the impacts and consequences of complexity (Langlois and Robertson, 1992; Loasby, 1976; Nickerson and Zenger, 2002; Rawley, 2010; Simon, 1962; Thompson, 1967; Williamson, 1975). Beginning in the 1960s with the open-systems view of organizations, complexity has been a central construct in explaining the internal and external interconnectedness of organizations (cf., Anderson, 1999). For example, in his seminal article on the architecture of complexity Simon (1962: 468), although avoiding undertaking any formal definition of complexity, describes a complex system as "*one made up of a large number of parts that interact in a nonsimple way*". Such a system requires hierarchies with property of near-decomposability which simplifies behavior to be effective. In a similar manner, Thompson (1967) portrays a complex organization as a set of many interdependent parts. He argues that complexity is an inherent component of all organizations, and that a central challenge for organizations is to cope with the consequences of complexity. Changes in the organizational design have thus been regarded as firms' effort to match the complexity of an organization's structure with the complexity of its environment and technology (Galbraith, 1973).

Complexity exists when a large number of elements are interdependent (Lawrence and Lorsch, 1967; Thompson 1967). Whether pooled, sequential or reciprocal, interdependencies link together individual parts of an organization in such a way that the joint outcome of the activities depends on the contributions of these individual parts (Van de Ven *et al.*, 1976). An organization is complex if change in one unit requires change in many other units. For example, complexity is present if changing one set of operating routines requires that a large number of other operating routines are correspondingly changed (Nelson and Winter, 1982). Moreover, it is assumed that this type of complexity results in combinatorial complexity in which the addition of one element to an interdependent system exponentially increases the total number of possible interfaces and interdependencies (Ethiraj and Levinthal, 2004).

In this paper, we follow the interdependency view on complexity by proposing that complexity exists in systems characterized by a large number of interdependencies. However, rather than treating complexity as a comprehensive unanimous construct, we argue that several types complexity may exist simultaneously (e.g., complexity in organizations, tasks, projects, etc.) and that it is important to keep these theoretically apart. Specifically, we focus on two types of complexity to elucidate an ambivalent effect on firm performance: configuration complexity and task complexity.

First of all, configuration complexity may exist when a large number of organizational divisions and units are interdependent (Aiken et al., 1980; Blau and McKinley, 1979; Damanpour 1996). Configuration complexity thus refers to both the number of organizational sub-units and the degree to which these sub-units are interdependently connected. For example, Siggelkow (2001) uses the case of the fashion company Liz Claiborne to map and analyze the complexity arising from a large number of internal and external interdependencies between major internal value chain activities (e.g., the product portfolio, marketing, production, etc.) and environmental factors (e.g., distribution channels, consumer preferences, etc.).

At the task level, complexity may equally exist in situations characterized by a high number of interdependencies (Campbell, 1988; Wood, 1986). Task complexity can be defined as the extent to which the task consists of various interdependent sub-tasks, the presence of inexact and unknown means-ends connections, and the related existence of path-goal multiplicity (e.g., Campbell, 1988; Wood, 1986). For example, product complexity has been defined as the number of parts in the product (Murmann, 1994). Hogarth (1980) defines the complexity of a decision task as the number of alternatives and the number of decisions per alternative, the extent to which dimensions are commensurable, order of information presentation, familiarity with the kind of decision task, and missing information concerning dimension on particular alternatives.

In the next section, we investigate how configuration and task complexity affect performance in a relatively new, yet fast growing and increasingly important industry: global business services (Ethiraj et al., 2005; Dossani and Kenney, 2007).

The global service provider industry

Facilitated by increasing digitalization and commoditization of business processes (Davenport, 2005), and driven by cost, speed, access to talent and other strategic advantages (Lewin and Peeters, 2006; Manning et al., 2008), client firms across industries, from the U.S. and Western Europe in particular, increasingly outsource business processes to specialized service providers operating across the world (Couto et al., 2008; Massini et al., 2011). Providers include large players such as U.S.-based Accenture, IBM, and HP; and India-based Infosys, Genpact, and

Wipro; as well as numerous small and midsize providers. Typically outsourced processes include IT infrastructure, payroll, tech support, inbound and outbound calls, but also software development and testing, engineering support and product design (see for an overview Couto et al., 2008).

Increasing client demand for services outsourcing has been paralleled by a sophistication of supply of various services and the development of client-serving capabilities (Athreye, 2005; Ethiraj et al., 2005). For example, several large providers headquartered in India have developed so-called global delivery models involving distributed teams at both onshore (client-side) and offshore facilities, collaborating across time zones (Govindarajan and Ramamurti, 2011). Over time, many providers have not only expanded their portfolio of services, but also their global presence through distributed delivery centers. Increasing commoditization of services and resulting competition for client projects have promoted this differentiation strategy. However, the increasing ability to provide numerous services globally through distributed delivery structures has also increased the configuration complexity of service operations. Similar to client firms with large-scale internal offshore operations (see e.g. Massini et al., 2010), full-service providers are challenged by increasing coordination and overhead costs affecting not only cost savings for clients but their own margins as well. This is why the provider industry continues to be populated by both large, differentiated providers and small, specialized vendors operating locally.

Beside an increasing range of configuration complexity in the community of business service providers, the range of tasks and services – from simple and highly standardized, to complex and advanced – has increased as well. Whereas prior to 2000, most service providers focused on commoditized IT and software services (see e.g. Arora et al., 2001; Dossani and

Kenney, 2007; Ethiraj et al., 2005), over time providers have not only increased the spectrum of more standardized task and service offerings (e.g., finance and accounting, HR, call centers and tech support (see e.g. Sako, 2006)), but also more complex, often knowledge-intensive tasks, such as engineering, design, and analytical services (Lewin et al., 2009). Similar to the expansion of service portfolios and globally dispersed operations, the addition of more complex services has been an important differentiation strategy facing increasing process commoditization and resulting cost pressures (see also Sako, 2006; Couto et al., 2008; Manning et al., 2011).

Differences in both configuration and task complexity have important performance implications for providers which we seek to better understand in this study. Interestingly, many prior studies on global services outsourcing have been focused on client interests in cost savings, service quality, data security and reliability (see e.g. Luo et al., 2013; Dibbern et al., 2008; Ellram et al., 2008), whereas the interests of providers e.g. in profitability and survival have been somewhat neglected (but see e.g. Lahiri and Kedia, 2009; Lahiri et al., 2012). In particular, as processes become more commoditized and competition for client projects increases, pressure on margins is also increasing which threatens profitability for providers. Rather than emphasizing client interests, we therefore focus explicitly on the generation of provider's margins as a primary performance indicator (see also Mayer and Nickerson, 2005; Mayer and Salomon, 2006). Next, we develop propositions on the effects of configuration and task complexity on provider performance.

Configuration complexity in the global service provider industry

As argued above, configuration complexity points to organizations consisting of a large number of interdependencies that require substantial coordination to ensure joint designing, joint scheduling, and mutual adjustments, as well as setting transfer prices and designing incentive schemes for cooperation. In this respect, a central consequence of complexity relates to increased coordination costs that may outweigh potential gains (Zhou, 2011; Larsen et al., 2012). In order to understand the factors affecting each other's decisions and to track the decisions that are made, interdependent elements must be coordinated (Arrow, 1974; Becker and Murphy, 1992). However, coordination, particularly in complex systems, is costly. Rawley (2010), for example, argues, based on data on taxicab and limousine firms, that the coordination costs of diversification offset economies of scope and that organizational rigidity further increases coordination costs. Relatedly, Zhou (2011) argues that the potential synergistic benefits associated with related diversification among U.S. equipment manufacturers may be offset by the complexity of managing the interdependencies between different business lines. In general, diversification of operations results in a higher number of organizational units that to various extents are interdependent on each other, and thus need coordination. The increasing number of interdependencies adds coordination costs, and, unless appropriately managed, outweighs the intended gains of diversifying.

Service providers increase configuration complexity mainly in two respects: services offered and service locations. As argued above, many service providers have diversified and increased their service offerings over time, while others are positioned as highly specialized service providers (Couto et al., 2008; Massini et al., 2010). On the other hand, service providers are increasingly internationalizing their activities. Whereas most providers started with local operations for example in India (e.g. Arora et al., 2001; Dossani and Kenney, 2007), occasionally sending service teams to client sites on a project-by-project basis (Ethiraj et al., 2005), many have expanded their operations not only by setting up permanent nearshore services centers close to major clients (see e.g. Govindarajan & Ramamurti. 2011), but also by adding other offshore sites in Latin America, Africa and other regions (Lewin et al., 2010). Yet, beside an increasing number of global players, the number of entirely local vendors has increased as well. In both respects – number of services offered, and number of locations with service operations – the range of providers from very low to very high degree of configuration complexity has increased over time.

A consequence of this trend is that, depending on their configuration complexity, service providers differ in the extent to which they must coordinate activities across service areas and geographic distances. While a service provider offering a large number of different, perhaps unrelated, services through operations in a number of different countries may be attractive to certain types of clients, such a provider is also more likely to encounter higher coordination costs than a service provider offering only one service out of one country. Since coordination costs add to costs involved in performing services for particular clients, we argue that, ceteris paribus, higher coordination costs negatively influence the margins that the service providers can appropriate from their services (Larsen et al., 2012; Rawley, 2010; Zhou, 2011). Accordingly, we hypothesize:

Hypothesis 1a: Configuration complexity based on service provider diversification of services and service locations is negatively related to vendor margins.

According to this logic, the means by which cross-unit processes in a multi-unit service organization are coordinated should have an effect on the negative relationship between configuration complexity and vendor margins. For example, Srikanth and Puranam (2011) find that the negative impact of interdependencies between offshore and onshore tasks on performance are moderated by certain coordination mechanisms such as modularity, ongoing communication and tacit coordination (see similar Levina and Vaast, 2008; Manning et al., 2013). In order to better understand the effect of configuration complexity, we argue in the following that in particular the degree of process commoditization positively moderates the negative association with vendor margins.

Process commoditization can be defined as the extent to which a service or process is standardized, modular and unspecific to particular end products or organizations within or for which the process is performed (Davenport, 2005; Sako, 2006; Tanriverdi et al., 2007). Prior studies have argued that business processes, including more knowledge-intensive processes, are becoming increasingly commoditized (Sako, 2006; Couto et al., 2008; Manning et al., 2008). As service providers are able to offer commoditized services at lower costs, client firms are less incentivized to internalize the delivery of these services (Tanriverdi et al., 2007). To a large extent, the commoditization of services has been a main reason for the significant growth of the global service provider industry (Sako, 2006; Manning et al., 2011). In addition, we argue that process commoditization also allows providers to diversify operations while keeping coordination costs relatively low.

This is because commoditization combines two features which affect cross-unit coordination: process standardization and modularization. First, commoditization is based on the standardization of processes, including process activity and flow standards, process performance standards, and process management standards. Standardization may facilitate hand-offs; ease comparative measures of performance; and make information less ‘sticky’, i.e. less difficult to communicate (von Hippel, 1994; Szulanski, 1996; Kumar et al., 2009). Second, commoditization is based on the principle of modularity (e.g., Baldwin and Clark, 2000). Modularity describes the degree to which interfaces between systems or processes are specified in such a way that they can be operated or performed with minimized interaction or coordination (Baldwin and Clark, 2000; Ethiraj and Levinthal, 2004b; Sanchez and Mahoney 1996). As a result, relations between units performing certain processes are characterized by ‘thin crossing points’ (Baldwin, 2008) which reduce for example the need for frequent face-to-face interaction thus making global distribution more feasible (Apte and Mason, 1995). More generally, modularity reduces the need for costly coordination as it entails hierarchies with property of near-decomposability that simplifies behavior (Ethiraj and Levinthal, 2004). Modularity has therefore been seen as an important coordination mechanism to overcome the negative consequences of complexity (see Simon, 1962).

Thus, we argue that commoditization is a mechanism that reduces the negative impact of configuration complexity. By standardizing and modularizing processes related to performance, flow, and management (Davenport, 2005), a high degree of commoditization reduces coordination costs, and, accordingly, addresses the configuration complexity that arises as service providers diversify. As such, it reduces the scope for unintended consequences of complexity to emerge (cf. Baldwin and Clark, 2000). We therefore hypothesize:

Hypothesis 1b: The negative association between configuration complexity and vendor margins is positively moderated by the degree of process commoditization.

Task complexity in the global service provider industry

Task complexity refers to the complexity of the individual activities within the organization (e.g., Campbell, 1988; Wood, 1986). This complexity may refer to many aspects, such as tacit knowledge flows, the presence of inexact and unknown means-ends connections, the number and interdependence of subtasks, and the existence of path-goal multiplicity (e.g., Campbell, 1988; Wood, 1986). Generally, task complexity comes from a high number of interdependencies inherent in the task that creates uncertainty regarding input, the process, and intended output. In the context of business services, typically knowledge-intensive services, such as engineering, product design, software development and analytical services, are considered to be relatively complex, compared to more routine services, such as payroll processing, IT infrastructure and accounting (see e.g. Kenney et al., 2009). Complexity, however, may also derive from the number of interfaces with other processes or systems, even if performing the process itself does not require advanced technical or analytical skills. Importantly, research suggests that the number of service providers offering complex, more or less knowledge intensive services has increased over time (Couto et al., 2008) – also thanks to their growing access to globally dispersed talent pools and expertise – which, in turn, has stimulated client demand for such services across industries (Manning et al., 2008; Lewin et al., 2009).

In comparison with simpler tasks for which aspects such as input and output requirements are easily defined, complex tasks with often vague and ambiguous requirements are more likely to expose decision makers to bounded rationality and uncertainty (Campbell, 1988; Wood, 1986). In a study of R&D offshoring projects, Manning et al. (2013) show how decision-makers underestimate the ambiguity of particular tasks and interfaces between tasks affecting interactions and communications with offshore teams. Accordingly, research has often associated task complexity with consequences such as delayed development time (Byström and Järvelin, 1995), hidden costs (Larsen et al., 2012), higher and often unexpected monitoring requirements (Dibbern et al., 2008), and high coordination costs (Brusoni, 2005; Kumar et al., 2009). This research, however, has focused mainly on more or less anticipated consequences of relocating complex tasks, such as R&D, from a client perspective (see e.g. Gertler, 2003; Von Zedtwitz, 2004).

By contrast, from the viewpoint of providers, task complexity may have different consequences for performance. We argue that task complexity in this context can be expected to positively affect vendor margins. This is mainly because task complexity creates information asymmetry between clients and service providers. Information asymmetry occurs when one partner has relevant information that the other partner does not have (Akerlof, 1970). Task complexity raises the probability that there will be information asymmetry between the client and the provider, as it implies specialized knowledge and processes that are only known by the service provider. More complex tasks may also require more qualified personnel, more advanced technologies, etc. In fact, lack of client process knowledge – along with lack of access to relevant skills, expertise and technologies – may be a driver for them to source these processes from specialized providers in the first place (Lewin et al., 2009). In addition, services – compared to tangible products – are particularly likely to create information asymmetries due to the difficulties of evaluating their intangible elements along with conditions of successful implementation in the client organization (Nayyar, 1993: Manning et al., 2011; see similar for consulting services, Sturdy, 1997).

Whether caused by moral hazard or adverse selection, a central consequence of information asymmetry is the increased probability of opportunistic behavior (Williamson, 1985), which is often associated with so-called ‘agency costs’ from the perspective of principals (the clients) who lack relevant information vis-à-vis agents (the providers) (Jensen and Meckling, 1976). These costs from the perspective of clients may translate into economic rents for providers as they exploit ‘zones of uncertainty’ (Crozier and Friedberg, 1980) in terms of specialized knowledge involved in the performance of tasks that is unattainable by the client.

Thus, tasks of greater complexity allow service providers to appropriate higher economic rents generating higher margins. This leads to the formulation of the following hypothesis:

Hypothesis 2a: Task complexity is positively related to vendor margins.

Since information asymmetry allows the vendor to appropriate higher economic rent and margins from complex tasks, measures that reduce information asymmetry should negatively moderate the relationship between task complexity and performance. In the following, we focus on the role of client-specific investments into training, and software as a moderating mechanism affecting information asymmetry.

Client-specific investments can be understood as investments providers need to make into processes and technologies supporting service operations that make these processes and technologies more specific to client operations and requirements (see e.g. Dyer and Singh, 1998; Zaheer and Venkatraman, 1995). In the literature, client-specific investments are often associated with switching costs: The more relationship-specific particular processes and technologies are the more costly it is to switch to new vendors (or clients) (e.g. Barthelemy and Quelin, 2006; for the case of offshore outsourcing Luo et al., 2013; Manning et al., 2011).

However, beside the effect on switching costs, client-specific investments also affect information asymmetry resulting from task complexity. As providers align their processes and technologies with clients, e.g. by using the same process standards, by training staff according to client-specific requirements, by using the same software, or by applying the same performance evaluation criteria, processes become more transparent to clients, and easier to monitor and evaluate (Luo et al., 2013). This principle is well understood by OEMs undertaking active measures to train and 'develop' suppliers in line with their operational requirements (Dyer, 1996). While client-specific investments may increase the willingness of clients to outsource processes to particular vendors, they also reduce potential information asymmetries arising from task complexity. Even if clients are unfamiliar with sub-processes involved in performing particular tasks, a high level of process and client integration due to client-specific investments (Luo et al., 2013) generates more frequent and immediate feedback of vendor operations at client organizations and allows clients to track deviations from expected performance.

As a result, if client-specific investments are needed (or requested) to perform particular tasks vendors are less likely to exploit potential information asymmetries arising from task complexity. Therefore, a negative moderating effect of client-specific investments on the relationship between task complexity and vendor margins is expected. We hypothesize:

Hypothesis 2b: The positive association between task complexity and vendor margins is negatively moderated by the degree of client-specific investments.

In sum, we derive a theoretical model suggesting that configuration complexity has a negative effect on vendor margins, but that this effect is positively moderated by the degree of process commoditization. At the same time, task complexity has a positive effect on vendor margins, but this effect is negatively moderated by the degree of client-specific investments associated with these tasks. The joint model is depicted in Figure 1.

******Insert Figure 1 here******

METHODS

Data collection

We test our hypotheses based on data collected by the international Offshoring Research Network (ORN). The ORN is an international research initiative launched at Duke University, which involves partner universities in Europe and Asia. Since 2004, it has studied major offshoring drivers; risks; location choices; delivery model choices; performance indicators; and future plans from the perspective of client firms, as well as client-seeking strategies, risks, service and location portfolios, and performance indicators from the viewpoint of service providers, based on annual independent surveys of clients and providers respectively (see e.g. Lewin and Couto 2007; Couto et al. 2008; Manning et al., 2011). In the context of this study we exclusively use data from the service provider survey.

The service provider survey collects detailed information from business service providers across the world (since 2007). Survey participants give information on: the services they provide (e.g. IT services, software development, call centers etc.); the locations they provide services from (e.g. India, China, Brazil, etc.); their client base (e.g. client size and origin); perceived client expectations; perceived operational risks; strategies of attracting clients; contract renewal rates; savings and performance data; various features of services provided (e.g. degree of commoditization, complexity and client specificity); the year since they have provided particular global services; and future plans. Data are collected both at the firm level (e.g. firm size, client attracting strategies, perceived risks) and the service level (e.g. locations from which services are provided from, margins, service characteristics, contract renewal rates).

The survey has been taken online: some respondents reach the survey website through external links or email invitations, whereas others randomly open the website and register for the survey. Once registered and approved by the ORN survey team, respondents are added to the database. Typically not every respondent completes the survey right away. At regular intervals, registered users are reminded to complete the survey. However, in some cases, in particular large firm respondents (see below) would submit the survey uncompleted, resulting in a number of missing variables, despite reminders to answer all questions. This is a limitation of this rather comprehensive multi-level survey design.

As of 2012, the service provider database contains data from 755 providers based in different countries and regions. Among the providers in the sample are most major providers, including Accenture, Infosys, TCS, IBM Global Services, Genpact, Tata Consulting, Cap Gemini etc., but also numerous small and midsize players. It should be noted, however, that only 191 providers provided sufficiently detailed information resulting in a usable sample of 446 data points (as each provider on average have responded for 2.3 services) after removing responses with missing values. The subsample of 446 service-specific responses will be used for empirical testing of the hypotheses.

We examined the risk of nonresponse bias by comparing selective sample distributions of the completed responses sample (i.e. sample of firms with valid responses for all variables used in the model) with the missing responses sample (i.e. sample of firms with missing responses for some or all variables used in the model). In particular, we compared subsamples by firm size, headquarter location, and distribution of services specified. As for headquarter and service distribution, differences between subsamples are insignificant. This is unfortunately not the case for size. The completed responses sample is significantly biased towards small firms with less than 500 employees (60%) and midsize firms with more than 500 but less than 10,000 employees (32%) vs. large firms with more than 10,000 employees (8%). By comparison, the missing responses sample has a distribution of 25% large, 40% midsize and 34% small firms. The main reasons for this difference are difficulties many large firm respondents encounter when taking the detailed multi-level questionnaire with arrays of questions for each type of service. Although various methods exist to replace missing values (e.g., Royston, 2004), we decided to only use actual responses. We followed the rationale that respondents giving complete information are likely to be more accurate with any particular data item than respondents giving incomplete information. (Oftentimes the former – unlike the latter – would also consult other members of the organization to help complete the survey.) While the resulting exclusion of a number of larger firms might be a limitation, one positive side effect of the resulting bias towards smaller firms is that the initial overrepresentation of large firms in the total sample is corrected. This overrepresentation was initially due to the above mentioned strategy of including most major service providers. In practice, however, midsize and smaller firms are the vast majority of providers which is reflected in the completed responses sample.

Measures

The survey data includes 446 useable responses of providers offering different classes of service to clients all over the world. The size of the providers in the database varies from the smallest with only one employee to the largest with 550.000 employees. The providers are located all over the world and the three most important locations are: USA (33.9%), India (12.7%), and China (11.5%). The three most important classes of services offered are: IT (20.6%), Software (17.7%), and Call Centers (9.2%).

Common method bias is an obvious limitation of survey based measures. However, the questionnaire of the service provider survey consisted of different scales and some of them were reversed, which diminishes the risk of biases. In addition, we performed a number of statistical analyses to assess the severity of common method bias. In particularly, a Harman's one-factor test on the items indicated that common methods bias was not an issue. That is, multiple factors were detected and the variance did not merely stem from the first factors (Podsakoff and Organ, 1986). In fact, the items included in the model form several factors with an eigenvalue > 1 and with the two major factors only explaining 18% and 14%, respectively. In addition, we ran a confirmatory factor analysis where all items loaded on the same factor (a Single Factor Model).

The assumption is that the existence of a single factor that is the common denominator across all items reflects the presence of a common method bias (Podsakoff et. al, 2003). However, in our case the goodness-of-fit statistics is highly unsatisfactory for the Single Factor Model capturing the common method bias, which indicates that we do not have a major problem of common method bias in the data. Moreover, our results are based on complex estimations that involve multiple independent variables and interaction terms. It has been argued that it is highly unlikely that the results of such models emerge solely as a result of common method bias (Evans, 1985; Siemsen et al., 2010).

Dependent Variable

Vendor margins is a measure of the return (revenue – costs) obtained by the provider for each class of services that they offer to clients. Since no objective measure is available for vendor margins and in particular not at a disaggregated level, it was acquired as a subjective measure. More specifically, respondents were asked to indicate "for each class of services that your company provides, what is the average achieved margin (in %) on deals (once deals have been implemented)?" Respondents were asked to indicate the average margin in percentage (i.e. revenue – costs / revenue) over deals in the same class in order to even out fluctuations on individual deals. The margin can vary from a negative value if costs exceeds revenue to almost 100% if costs are negligible compared to revenue. The average margin across the 446 observations is assessed to be 26%, however, with significant variation as the standard deviation is 18.6% (see Table 2).

Independent variables

Task complexity is a multi-item measure capturing the complexity of the provided tasks. The variable is constructed as a reflective measure based on three items. The respondents were asked about the characteristics of the involved tasks for each class of services provided by the company. On a scale from 1 (=strongly disagree) to 5 (strongly agree) respondents were asked to indicate whether the involved tasks was "highly complex", "required very high level of client specific knowledge" or "required frequent interaction with client". The obtained Cronbach alpha-value for this construct was 0.65, and in the confirmatory factor analysis the construct obtained strong reliability, with values of 0.81 for composite reliability and 0.58 for average variance extracted (AVE) – see Table 1. All these measures indicate that the construct is highly reliable and characterized by convergent validity. Descriptive statistics on this variable (Table 2) show that the mean is 3.61 which are well above the median (of 3) on the 5-point scale.

Configuration complexity is a measure that captures the organizational complexity of the provider's activities (rather than the complexity of the individual tasks). This is measured through two items – diversification of functions and locations. However, we do not expect these two items to correlate and form a reflective construct, but rather that they both contribute to increase the configuration complexity. Therefore this variable is measured as a formative construct with the two items: number of functions where the provider is conducting activities and number of locations where the provider is conducting activities. The mean of this variable is 3.27 (see Table 2), but with a substantial variation given the standard deviation of 2.05.

Moderating variables

Client-specific investment is a measure of the extent to which the provider has to make investments that are specific to the particular client (and therefore of less value in other relationships). Respondents were asked "for each class of services that your company provides, to what extent does your company have to make client-specific investments?" They should indicate this on a 5-point scale (1=not at all and 5=to a great extent) for "client specific investments in software” and “client specific investments in training”. The Cronbach alpha-value was 0.57, and in the confirmatory factor analysis the construct obtained reliability, with values of 0.69 for composite reliability and 0.57 for average variance extracted (AVE) – see Table 1. The mean of the variable is 3.01 (Table 2), which exactly corresponds to the median of the 5-point scale.

Process commoditization is a two-item reflective measure capturing how commoditized the particular service has become. Commoditized services are services which are decoupled from client-specific or product-specific properties. Typically, highly commoditized services are based on process standards that are widely shared in the industry. Respondents were asked “for each class of services that your company provides, how commoditized has this service become?” and they indicated this on a 5-point scale (1=very low and 5=very high) for “extent of commoditization today” and “extent of commoditization in next 18-36 months”. The obtained Cronbach alpha-value was 0.87, and in the confirmatory factor analysis the construct obtained reliability, with values of 0.92 for composite reliability and 0.87 for average variance extracted (AVE) – see Table 1. The mean of the variable is 3.28 (Table 2), but with some variation given the standard deviation of 0.99.

******Insert Table 1 here******

Control variables

We include three control variables in order to control out other factors that might equally well affect the vendor margins. The three control variables are capturing effects on three different aspects: the provider itself, the relationship, and the deals.

The years of provider experience, i.e. the number of years that the company has been in the outsourcing business, is taken as a proxy for the competencies and resources that the provider has accumulated over the years and which is expected to have a positive effect on vendor margins. The average years of experience are 11.6 years, but with a span from 0 years to 85 years of experience (Table 2).

The longevity of customer relationship is controlled for as vendor margins might decrease in long-lasting relationships. The longevity is measured by asking respondents to indicate the percentage of relationship that have lasted more than a year. As shown in Table 2 on average 79.7% of the relationships have lasted more than a year.

In a similar way, the average duration (in years) of deals currently under contract is also controlled for as it might affect vendor margin negatively as well. The average duration of deals is 2.25 years (Table 2), however, with substantial variation spanning from 0 to 37 years (and a standard deviation of 2.71).

******Insert Table 2 here******

Statistical model

The proposed model was tested using a PLS analysis. PLS is a type of structural equation modeling (SEM) that applies regression-based calculation methods and not the maximum likelihood estimation methods used in other SEMs (like LISREL). PLS is a causal modeling approach aimed at maximizing the explained variance (R-square) of the dependent variable—in our case the vendor margins.

PLS allows developing complex models with latent variables that cannot be directly measured, such as task complexity, configuration complexity, client investment and commoditization, but must be analyzed through indirect means. PLS uses manifest variables, such as a respondent’s answer to a set of questions on the manifestation of the underlying construct, to estimate a given latent variable (Fornell and Larcker, 1981). The latent variable estimators can then be used to analyze relationships between various hypothesized constructs. This may include complex models with moderated relationships like in this case.

The advantage of PLS is that it requires fewer data assumptions (especially the multivariate normality assumptions); that it handles reflective as well as formative measures, and that it is better suited for more complex models (Hair et. al, 2011; Hulland, 1999). All these features make the PLS-analysis highly suitable for testing our model. The key feature of PLS that speaks to our analysis is its ability to cope with both formative and reflective constructs, and to simultaneously estimate the measurement and structural model.

RESULTS

The proposed model (shown in Figure 1) was analyzed using SmartPLS – version 2.0. SmartPLS assesses the properties of the measurement model and estimates the coefficients of the structural model taking into account the moderating latent constructs (Ringle et. al, 2005). The first step is to establish confidence in our measures (the measurement model) as these forms the basis of the structural model where our hypotheses are tested. Our model includes four single item, three two-item (of which one is formative) and one three-item construct. To ensure reliability and validity of our measures used for the various multi-item reflective constructs, we calculated composite reliabilities and report them in Table 1. The Cronbach alpha and composite reliability measures both provide information on how well the manifest variables measure the latent variables. The AVE-score on the other hand provides evidence concerning whether a set of manifest variables is a reasonable representation of the underlying latent construct. When the AVE score is greater than 0.50, there is a reasonable amount of confidence that the manifest variables are doing a good job in measuring the latent variable (Fornell and Larcker, 1981). In our case all three reflective constructs have AVE-scores well above 0.50.

To confirm that there is adequate discriminant validity among the various latent variables, the correlations among all the variables included in the model is reported in Table 2. None of the binary correlations are above 0.4. The fact that the correlation coefficients are small or moderate indicates that the latent variables have adequate discriminant validity. In the diagonal element of Table 2, we show the square root of the AVE-score for each of the three multi-item reflective constructs (the Fornell and Larcker criterion). As can be seen from Table 2, the square root of the AVE-score by each latent variable is much higher than the correlation between the latent variable and all other latent variables. This demonstrates that the different multi-item variables extract a higher share of variances from their own items than from other latent variables.

After having reached at a satisfactory measurement model, we can proceed to evaluate the structural model including the model path coefficients. Model path coefficients are equivalent to standardized regression coefficients, and can be interpreted in the same way. A one-unit increase in an independent variable will be expected to cause an increase in the dependent variable equal to the path coefficient.

Standard errors of the path coefficients are obtained by bootstrapping the sample 5,000 times (Hair et. al, 2011; Hulland, 1999). The model converged after only 8 iterations and the cross-validated redundancy measure (Q^2 scores) was positive for all constructs (Hair et. al, 2011). Based on the results, the model appears to represent an adequate fit to the data.

******Insert Table 3 here******

The PLS results with the path coefficients of the structural model are reported in Table 3. Three models are presented where Model 1 only includes the control variables, and Model 2 adds the main effects of the four explanatory variables, while the two interaction effects are also added in Model 3 in order to test for the moderation effects. In Model 1 two of the control variables are significant (both with the expected signs), but the R-square only obtains a value of 0.04. The R-square increases significantly to 0.09 in Model 2 where the four explanatory variables are added. The R-square increases further in Model 3 with the interaction effects obtaining a value of 0.12. The final model is therefore explaining 12% of the variation in vendor margins which is very satisfactory.

Task complexity is highly significant ($\beta = 0.20$, $p < 0.001$) and positive as expected indicating that providers can obtain higher margins the more complex the outsourced tasks. Configuration complexity that is capturing the complexity of the organization has, as expected, the opposite effects as it affects vendor margins significantly negative ($\beta = -0.09$, $p < 0.05$). As such both hypotheses 1a and 2a on the effect of task and configuration complexity are confirmed. While an increase in the complexity of the task paves the way for higher vendor margins, an increase in the complexity of the organizational setup entails costs and reduces the vendor margins.

Hypotheses 1b and 2b are tested by introducing the interaction effects in Model 3. The interaction effects between configuration complexity and process commoditization is positive and significant ($\beta = 0.11$, $p < 0.05$) as hypothesized. This implies that the negative effect of configuration complexity on vendor margins is reduced when the outsourced services are increasingly commoditized. Therefore, hypothesis 1b is confirmed. The interaction effect between configuration complexity and client-specific investment has the expected negative sign ($\beta = -0.12$, $p > 0.10$), but it is not significant – so hypothesis 2b must be rejected. This implies that client-specific investment might reduce the asymmetric information between client and provider (reflected in the negative coefficient), but not enough to have significant moderating effect on the relationship between task complexity and vendor margins. In fact, the standard error of 0.15 is larger than the coefficient of 0.12 signifying that the effects of client-specific investments vary substantially.

It is noticeable that both years of provider experience and duration of deals have a significant effect on vendor margins. Provider experience has a positive effect ($\beta = 0.14$, $p < 0.01$) as the provider obtains stronger competences, skills and resources over the years. While duration of deals has a negative effect ($\beta = -0.08$, $p < 0.05$), since long-lasting deals might have a similar tendency to reduce the asymmetric information between the two parties.

DISCUSSION AND CONCLUSION

While complexity has usually been associated with more detrimental consequences such as coordination costs, organizational inertia, and decision errors (Ethiraj and Levinthal, 2004; Thompson, 1967; Zhou, 2011), there are also arguments suggesting that complexity may function as a source of competitiveness (Hart, 1995; Lippman and Rumelt, 1982; Singh, 1997; Rueda-Manzanares et al., 2007). In this paper, we have questioned the specific contingencies that predict the effects of complexity on firm performance. We have used the empirical context of the highly competitive and dynamic global service provider industry to fulfill this purpose (cf. Ethiraj et al., 2005; Lewin and Peeters, 2006; Manning et al., 2008). Given its rich variety of services, firms, and highly innovate, competitive and fast-changing markets, the global service provider industry has proven to be a very suitable case to study the relation between complexity and performance.

We have argued that configuration complexity is negatively related to performance (due to rising coordination costs (Larsen et al., 2012; Zhou, 2011)), while task complexity is positively related to performance (due to information asymmetry (Nayyar, 1993)). To further bolster our arguments, we expected process commoditization—a mechanism that lowers coordination costs (Davenport, 2005)—to moderate the effect of configuration complexity on performance, and client-specific investments—a mechanism that lowers information asymmetry (Zaheer and Venkatraman, 1995; Uzzi, 1997; Dyer and Singh, 1998)—to moderate the effect of task complexity on performance.

We found empirical support for three of our four hypotheses. On the one hand, we found that configuration complexity has a negative effect on vendor margins (Hypothesis 1a), and that this is positively moderated by process commoditization (Hypothesis 1b). On the other hand, we found that task complexity is positively related to vendor margins (Hypothesis 2a), but we did not find any significant results suggesting that this relationship is negatively moderated by client-specific investments (Hypothesis 2b). An explanation for this may relate to the provider's ability to make client-specific investments, for example by using the same software the client uses, without necessarily giving up control advantages. This might be different for cases where clients get directly involved in monitoring and service delivery. Future studies need to investigate this subtle difference. .However, as the main purpose of this paper has been to understand why diverging effects of complexity on firm performance may be obtained (i.e. the negative effect of configuration complexity and the positive effect of task complexity), we can argue, based on our findings, that our main conclusions are still valid.

This paper contributes to ongoing research that investigates the effects of complexity in organizational systems (Langlois and Robertson, 1992; Loasby, 1976; Nickerson and Zenger, 2002; Rawley, 2010; Thompson, 1967; Williamson, 1975). Seeing complexity as systems characterized by a large number of interdependencies (e.g., Simon 1962), research has tended to treat complexity as a one-dimensional construct (e.g., either configuration complexity or task complexity) that may provide organizational consequences such as inefficiencies, inertia and lack of response capacity (e.g., Anderson, 1999; Moldoveanu and Bauer, 2004; Park and Ungson, 2001; Robson *et al.*, 2008) and potential opportunities such as inimitable business systems (cf., Hart, 1995; Lippman and Rumelt, 1982; Singh, 1997; Rueda-Manzanares et al., 2007). However, as demonstrated in this paper treating complexity as a broad one-dimensional construct is likely to omit its multifaceted nature and eventually its effect on firm performance. Rather, to predict how complexity may either dilute or mend firm performance, a key message of this paper is that a more fine-grained understanding of complexity is needed that takes into account underlying mechanisms such as coordination costs and information asymmetry that eventually impact performance. As such, future research on the relationship between complexity and performance should embrace complexity as a multilevel phenomenon that not necessarily provides uniform results (for a similar multilevel approach, see Nielsen and Nielsen, 2012).

Our results suggest that firms may experience lower performance as a result of configuration complexity and, in the context of the service provider industry, specifically through diversification to provide an increasing number of services globally through distributed delivery structures. In this respect, complexity creates coordination costs that outweigh intended benefits (see also Larsen et al., 2012). These results hence lend support to a more negative characterization of the consequences of complexity (e.g., Moldoveanu and Bauer, 2004; Park and Ungson, 2001; Robson *et al.*, 2008; Zhou, 2011). At the same time, our results also suggest firms may benefit from making tasks and services more complex. By offering more complex tasks and services, providers are in a position to reap benefits of information asymmetry and can therefore appropriate higher margins. Accordingly, instead of viewing information asymmetry as an operational or strategic obstacle, we argue that it can be viewed as an important source of competitive advantage for those service providers that consciously exploit it (see also Nayyar, 1993). Our combined results therefore suggest that complexity may serve as an important revenue opportunity, but only to the extent that it can be isolated within specified tasks or services. Assuming that firms can keep the coordination costs of complexity at bay through mechanisms such as commoditization (Davenport, 2005) or modularization (Baldwin and Clark, 2000), complexity can be regarded as an important revenue opportunity.

In addition, we identify and discuss specific mechanisms that mitigate the effect of complexity on performance. Indeed, a central challenge for organizations is to cope with the consequences of complexity (Thompson, 1967). However, while extant research has typically emphasized changes in the organizational design as firms' effort to match the complexity of an organization's structure with the complexity of its environment and technology (Ethiraj and Levinthal, 2004; Galbraith, 1973; Siggelkow, 2001; Russo and Harrison, 2005), we argue that process properties, such as the level of commoditization, are equally important moderating factors to manage complexity. At the same time, we argue (though unable to support empirically) that client-specific investments have, from the perspective of the provider, a negative impact on the relationship between complexity and performance. Future research could therefore investigate how different process properties, in contrast to organizational design efforts, may moderate the effects of complexity, and eventually serve as strategic mechanisms to increase performance.

Finally, our findings contribute to a more nuanced understanding of performance conditions in the service provider industry. Whereas many studies have taken a client view, emphasizing the need of clients to save costs and mitigate risks associated with providers (e.g. Narayahan et al., 2011; Luo et al. 2013), we take a provider's perspective. In particular, we emphasize key tensions facing providers between the need to increase the scope and distribution of operations along with client-specific investments to attract clients, which however puts pressure on margins, and the possibility to commoditize processes, yet also focus on more complex tasks to generate revenue opportunities (see also Sako, 2006; Couto et al., 2008). Importantly, we demonstrate how agency costs (Jensen and Meckling, 1976) may function as a crucial performance determinant in an industry characterized by a rich variety of services, firms, and highly innovate, competitive and fast-changing markets.

Limitations and future research

This study contains limitations that future research should address. In particular, the failure to find empirical support for Hypothesis 2b merits research into understanding the specific mechanisms that moderate task complexity and information asymmetry in the service provider industry. Presumably, significant results would have been obtained if our analysis allowed us to measure the extent to which client-specific investments actually were aligned with client preferences (and the extent to which clients get involved in training, monitoring and other related activities). Future research could therefore investigate how different ways of aligning processes with clients affect information asymmetry and performance.

In relation to this, we have only relied on data from service providers, and thus omitted data from their clients. Although we emphasized the service provider perspective employed in this paper as a strength vis-à-vis only emphasizing clients, the inclusion of the client's perspective would, among other things, facilitate measurements of the degree to which for example client-specific investments where aligned with client preferences. Future research should therefore strive to include data from providers and clients.

Finally, we have only discussed performance in terms of vendor margins. Though this is not an uncommon measurement of firm performance, and in particular in highly innovative, competitive and fast-changing industries, there are reasons to question this measure. For example, sales growth (Lahiri and Kedia, 2009) or the rate of deal renewal with clients (e.g., Manning et al., 2011) may be equally important performance measures in the service provider industry. Future research could therefore investigate the relationship between complexity and alternative measures of performance.

Concluding remarks

In conclusion, this paper addresses the effect of complexity on firm performance by arguing that this relationship can best be explained as ambivalent. By demonstrating how different levels of complexity analysis yield opposite results for performance, it is our hope that future research will continue investigating other, more specific contingencies that explain how complexity may be seen as a threat as well as an opportunity for firms operating in highly competitive industries such as the service provider industry.

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Figure 1: Theoretical model

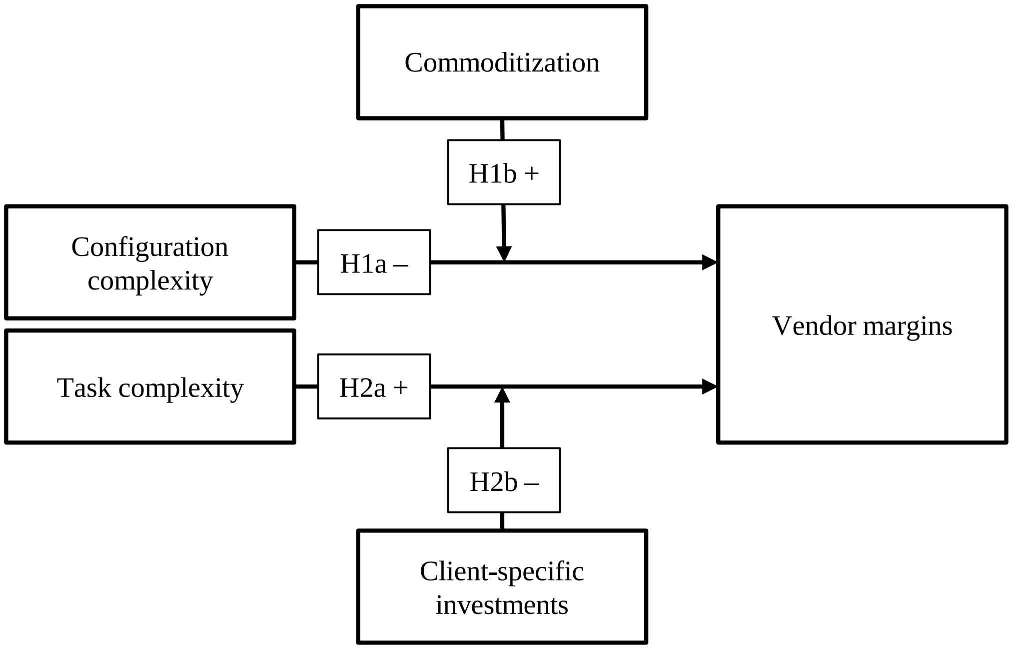

Table 1: Assessment of the applied reflective constructs*

	Average Variance Extracted	Cronbach's Alpha	Composite Reliability
Task complexity	0.58	0.75	0.81
Client-specific investment	0.57	0.67	0.69
Commoditization	0.87	0.87	0.92

***Configuration complexity is measured as a formative construct obtaining a communality of 0.5

Table 2: Latent variable correlations (n=446)

	1	2	3	4	5	6	7	8
1) Task complexity	*0.76*							
2) Configuration complexity	0.04	1.00						
3) Client-specific investment	0.19	0.13	*0.75*					
4) Commoditization	-0.23	-0.11	-0.05	*0.93*				
5) Provider experience	0.09	0.16	0.05	0.01	1.00			
6) Duration of deals	0.11	0.06	0.14	0.01	0.32	1.00		
7) Customer relationships	0.08	0.20	0.15	-0.01	0.36	0.17	1.00	
8) Vendor Margin	0.17	-0.15	-0.02	0.02	0.17	-0.13	-0.11	1.00
Mean	3.61	3.27	3.01	3.28	11.6	2.25	79.7	26.0
Standard deviation	0.77	2.05	0.94	0.99	8.95	2.71	21.2	18.6
Min. value	1.33	0.50	1.00	1.00	0	0	0	0
Max. value	5.00	13.5	5.00	5.00	85.0	37.0	100	100

Table 3: Structural path coefficients (standard error in parentheses)

	Model 1	Model 2	Model 3
Task complexity		0.21*** (0.04)	0.20*** (0.04)
Configuration complexity		- 0.12** (0.04)	- 0.09* (0.04)
Client-specific investment		- 0.01 (0.06)	- 0.04 (0.06)
Commoditization		0.06 (0.06)	0.05 (0.06)
Task complexity * Client investment			- 0.12 (0.15)
Configuration complexity * Commoditization			0.11* (0.05)
Control variables			
Years of provider experience	0.13** (0.04)	0.13** (0.04)	0.14** (0.04)
Duration of deals	-0.08* (0.03)	- 0.09* (0.03)	- 0.08* (0.03)
Longevity of customer relationships	-0.05 (0.05)	-0.04 (0.05)	-0.04 (0.05)
N	446	446	446
R-square	0.04	0.09	0.12

Ϯ, *, ** and *** indicates a level of significance of 10%, 5%, 1% and 0.1%, respectively