Modeling the operational capabilities for customized and commoditized services

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Abstract

According to the extant service operations management literature, substantial gains can be achieved for providers that are adept at aligning internal operational capabilities with customer needs. However, the most influential models in the field attempt to explain this alignment without regard to the core resource allocation choices relating operational capabilities to different service offerings. To further our understanding of service operations alignment, we apply a unique combination of experimental scenarios and discrete choice modeling to measure the role of managers in orchestrating operational capabilities. Using the third-party logistics tender review and bid preparation process as an empirical setting, we reveal the resource allocation choices that managers make between six distinctive operational capabilities (customer engagement, cross-functional coordination, creative solutions, operations improvement, IT infrastructure and professional delivery) and show the subtle ways in which these capabilities interact as the service context moves from one based on commoditization to one based on customization.

Keywords: service operations, strategic alignment, discrete choice analysis, capabilities.
1 Introduction

In order to compete successfully, organizations need to align their strategies and capabilities with their customer needs. This primary concept underpins the service operations management literature that emphasizes the need to bundle goods and services in ways that reflect the relative importance of each component to the customer (Normann, 2000; Roth & Menor, 2003). Among the more important decisions made by managers are choices about how best to allocate operational capabilities that align with customer needs. Alignment in service design is conceptually well grounded, and recognizes the distinction between value creation and capture (Lepack et al., 2007) and the central role of the customer in service design (Vargo & Lusch, 2004; Sampson, 2012). Yet the operations management literature has long lamented the lack of empirically based work to guide managerial actions (Goldstein et al., 2002; Machuca et al., 2007; Ponsignon et al., 2011).

According to resource-based theory (RBT), firms are likely to gain a relative advantage vis-à-vis their competitors when that firm’s managers can estimate the future value of an operational capability better than their competitors (Kraaijenbrink et al., 2010). However, the role that managers play in orchestrating internal resources and operational capabilities remains one of the most underdeveloped aspects of resource-based logic (Sirmon et al., 2011). This gap is visible in operations management, where the focus is commonly on “generic outcome characteristics” (such as cost, quality, delivery and flexibility) at the expense of how

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1 Resources and operational capabilities are used interchangeably in this paper, reflecting the tendency towards inclusive definitions in RBT.
managers configure operational capabilities to create and capture value (Schroeder et al., 2002). The resource allocation decision — which includes operational capabilities — is important because “many of the resources and capabilities upon which competitive advantages are formed have their basis in the operations area” (Coates & McDermott, 2002, p. 437).

One reason why so little is known about the decision process that underpins alignment is that customer heterogeneity and process complexity makes the task particularly challenging. However, by definition, such heterogeneity and complexity constitute the reasons why value is created in a service exchange. In a service operations context, customer heterogeneity is reflected in customer preferences for commoditized services and highly differentiated services (Anderson et al., 2011). “Process complexity” refers to the degree of interaction and interdependency (otherwise known as complementarities) between the operational capabilities that are required to deliver a service. The critical and strategically important issues that follow are: 1) determining what operational capabilities are required for a commoditized service offering and a differentiated service offering, and 2) how these operational capabilities differ in their level of interaction. The literature has not addressed the question of how managers orchestrate operational capabilities (Priem & Butler, 2001; Sirmon et al., 2007), and we argue that future research needs to better understand the conditions under which service alignment is more or less effective.

This paper makes another contribution: we examine the endogenous role that managers play during the alignment process. Our emphasis on the choices that managers make in aligning value-generating operational capabilities departs considerably from the traditional approaches that label the state of alignment based on the post hoc level of consensus between operational
outcomes and organizational goals (Boyer & McDermott, 1999). Hitherto, researchers have ignored the important “deciding” aspect of alignment — where managers make choices about which of the many operational capabilities available to the firm will best align to a portfolio of customer service requirements. These choices reflect the value of operational capabilities and can be measured at the moment of their selection (Makadok, 2001).

This study goes beyond a reliance on survey or secondary data by utilizing an experimental methodology to test two propositions. An experimental approach allows for the explication of managerial choices in controlled scenarios that lead to less ambiguity regarding how managers interpret the relative importance of operational capabilities.2 This reduces the impact of an individual’s perception of the measurement instrument, allowing them to make better comparisons about which capabilities perform better in different service contexts. It also allows us to examine managers’ reactions to identical strategic and operational options in identical environments. The method has been shown to be effective in modeling complex social and economic behaviors in service operations management (Pullman et al., 2001), in IT service strategy (Richard et al., 2012), and in the design of government and public services (Verma et al., 2006).

Although experiments of this type represent one of the better ways to disassemble decision making, they are useful for prediction only to the extent that the experimental design provides realistic variants of the context in which actual decisions are made. Realism requires a depth of focus, which is achieved in this study by directing attention to the tender response and bid

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2 Strictly speaking, our approach is quasi-experimental, in that we do not experimentally manipulate the managerial characteristics and other factors that may influence outcomes. We do, however, account for them in the analysis.
preparation process in the third-party logistics (3PL) industry. The 3PL industry is a large, highly competitive, specialized intermediate service operations market where most providers renew between 15% and 30% of their contracts each year (Saipe & Seiersen, 2007). Deeper theoretical and empirical understanding of the way managers select operational capabilities during the contracting or tender review and bid preparation process is warranted, due to the size and strategic value of the 3PL accounts. For example, Burnson (2011) reports that revenues in the US alone were above $127 billion in 2010.

The remainder of the paper is organized as follows. The next section outlines the theoretical background to our work and presents the research propositions. The ensuing discussion outlines the research methodology and describes the empirical process whereby specific measures were developed to test our model. The results section quantifies the different ways that managers choose to compete with different capability levels. Finally, we present the implications of this research for both scholarship and management practice.

2 Theoretical background

2.1 Perspectives on alignment and the resource-based theory

The alignment of supply with demand is core to operations management (Cachon & Terwiesch, 2012). Operations management scholars have traditionally measured the state of alignment by assessing the degree of consensus, convergence or congruence between objects. This is achieved by measuring the “level of agreement within the organization regarding the relative importance of cost, quality, delivery and flexibility to the organization’s operational goals, as well as the relationships between these competitive priorities and operational policies” (Boyer & McDermott, 1999, p. 290). By comparing the scores on these characteristics, researchers can report the presence or absence of alignment. This approach
tells us what level of alignment was achieved and whether increased congruence between objects leads to increased performance (Hill, 1985). A small number of scholars have come to see alignment as a process of related choices based on individual cognitive characteristics that play a key role in assessing the value of specific resources and operational capabilities throughout the organization (Hanson et al., 2011). This viewpoint directs our attention to the central role that managers play in the way resources are built and deployed to account for changing market circumstances (Adner & Helfat, 2003; Ambrosini & Bowman, 2009). This viewpoint is important because service design models, such as the service strategy triad (Roth & Menor, 2003), have little to say about the choices that managers make about which specific service design capabilities will be required to satisfy diverse customer markets.

Resource-based theory posits that a firm’s ability to create and appropriate value stems from differences in the possession of resources (Barney 1991), as well as the decisions by managers about the orchestration of resources (Sirmon et al., 2007). To explicate the role of managers in RBT, Sirmon et al. (2007) propose a resource management framework that reflects the partially sequential actions of managers. They define resource management as “the comprehensive process of structuring, bundling and leveraging the firm’s resources with the purpose of creating value for customers and competitive advantages for the firm” (p. 1392). Structuring is based on the acquisition and accumulation of a portfolio of resources. Once a portfolio of resources is in place, the firm can then bundle resources into operational capabilities. These operational capabilities then enable leveraging to occur. Thus, the ability to create value requires all three processes to be synchronized in ways that align with the service offering required by customers.
An operational capability can be considered valuable if it either enables customer needs to be better satisfied (Verdin & Williamson, 1994), or if it enables a firm to satisfy needs at lower costs than competitors (Peteraf, 1993). The argument that resources have value in relation to their ability, inter alia, to meet customers’ needs is entirely consistent within RBT (Makadok, 2001) and service operations management (Roth & Menor, 2003). Resource-based logic also recognizes that it is not easy for managers to form an accurate picture about the precise contribution a specific operational capability will make under conditions of customer heterogeneity and process complexity. Under a regime of uncertainty, where customer preferences vary and the variety and connectedness of the service offering is complex, the ability to determine value in any specific operational capability is subjective (Kraaijenbrink et al., 2010). This study seeks to explain the subjective resource management process whereby managers’ value operational capabilities, and then investigates how managers orchestrate operational capabilities in different service settings.

2.2 Operational capabilities and service operations management

Resource-based theory is characterized by inclusive definitions, where scholars appear to care little about whether constructs are labeled as “resource based,” “capability based,” or “competence based” (Kraaijenbrink et al., 2010). For example, Barney (2002, p. 155) defines firm resources as “all assets, capabilities, organizational processes, firm attributes, information, knowledge, etc. controlled by a firm that enable the firm to conceive of and implement strategies that improve its efficiency and effectiveness.” While he considers inclusiveness to be part of RBT’s strength, others believe it to be a weakness that generates ambiguity and confusion (Priem & Butler, 2001). Kraaijenbrink et al. (2010) argue that scholars need to recognize explicitly the differences among types of resources.
The focus in the present study is a subset of organizational capabilities that we define as operational capabilities. Drawing on Helfat et al. (2007) we define operational capability as the capacity of an organization to purposefully bundle its resource base in ways that enable the organization to perform the ongoing task of transforming inputs into outputs. The terms “capacity” and “purposefully” imply that managers make a choice about how best to leverage capabilities to align with a specific service objective. Our definition of operational capability is consistent with recent work in operations management (e.g., Wu et al., 2012).

An examination of the way managers align operational capabilities within a service design context requires researchers to examine the effects of the wide variety of operational capabilities that transform inputs into outputs. These include the role of people within the organization, the technological infrastructure required to achieve greater visibility and transparency throughout all aspects of the supply chain (Chase & Apte, 2007), and the centralized or distributed nature of location in relation to the customer (Ponsignon et al., 2010).

Although listing all the capabilities that are relevant to 3PL providers is not possible, certain types of capabilities can be recognized in all businesses that reflect the core processes for creating economic value. Day (1994) suggests that the most distinctive features of a customer-oriented organization is their mastery of “outside-in” and “inside-out” capabilities, along with “spanning capabilities” (pp. 40–41). Outside-in capabilities are associated with customer engagement; and inside-out capabilities are associated with the delivery pitch to the customer. Critical spanning capabilities are manifested in “typical business activities such as order fulfilment, new product development and service delivery” (p. 38). In the tender review and bid response context these capabilities are required to enhance learning and integrate...
specialist knowledge across functional units in the bid team, in order to create innovative customer-focused solutions, support information exchange with IT and maintain operational improvements in on-time and error-free delivery. Figure 1 graphically illustrates the distinctive capabilities that underpin value creation in the tender process in the 3PL industry.

< Figure 1 here >

3 Research propositions

How managers best allocate operational capabilities to new and existing business opportunities is an important managerial function that has been under investigated. These choices require managers to consider and make trade-offs between a number of operational capabilities based on what they believe will create the most value. Porter and Siggelkow (2008) propose that managers must also understand context to avoid misjudging the subtle ways in which resources and capabilities interact under different market conditions. The present study seeks to build on this work by uncovering differences in the ways that managers allocate distinctive operational capabilities to align with two service contexts: one based on commoditization and the other on customization.

3.1 Aligning stand-alone operational capabilities in commodity service contexts

Logistics is a turbulent industry where customers can be quite varied in terms of their demands, and highly sensitive to price variability. Empirical studies confirm this view and indicate that customers often view logistics companies as commodity providers that offer tools for reducing operating costs and improving basic logistics services, such as speed and reliable delivery (Anderson et al., 2011). A commodity is considered to be a non-differentiated service offering that is sold primarily on the basis of price (Samuelson, 1948).
The core components of a commodity are well known, mostly stable and widely shared amongst competing firms. Weill and Ross (2009) suggest that companies such as United Parcel Service (UPS) have long benefited from a clear operating model that offers a highly standardized end-to-end service delivery package. In commoditized service settings, standardized delivery enables the sequencing of activities to compete on price by reducing overall production costs that leverage common factors of production across locations (Campbell & Goold, 1998; Dewett & Jones, 2001).

Work in service operations provides a hint as to the operational capabilities that will be important in a commoditized service setting. For example, it is expected that managers will place a heavy emphasis on sustained incremental improvement capabilities that enable specialist knowledge to be exchanged, in order to lower costs and improve service delivery (Grant, 1996). The customer contact model holds that less direct contact with the customer will enable managers to develop service delivery systems that operate at peak efficiency, as required by commodity markets (Chase, 1978). Thus, information technology that enables firms to share information across products, management services, and locations will be important.

When orchestrating a portfolio of operational capabilities for a commoditized service offering some operational capabilities will be executed adequately, others poorly; but a few must be superior to the competition if the business is to sustain a market position that is valuable and difficult to match (Day, 1994). It is important, therefore, to know which operational capabilities create a distinctive capability, rather than being simply part of a sequential series of necessary activities. It is also important to know if the operational capability will create positional advantage without interacting with other operational capabilities. Schmidt and Keil
(2013, p. 211) describe this situation as comprising stand-alone improvements that arise “due to the availability of new technology that reduces average costs or that allows new product features that increase customers’ willingness to pay.” Indeed, the success and failure of market-leading service providers such as DHL relies on the fact that the managers of firms are making more strategically appropriate decisions than others (Coltman et al., 2010).

Experienced decision makers will recognize the discrete benefits from distinctive operational capabilities in a commoditized service setting where competitive pressures are high and the relationship between the service provider and the customer is primarily formed on the basis of price. Thus we propose:

P1: In markets characterized by commoditized service delivery, managers will perceive greater direct benefits from stand-alone operational improvement capabilities that support standardized end-to-end solutions, than they will in markets characterized by customized service.

### 3.2 Aligning complementary operational capabilities in customized service contexts

In a customized (or differentiated) service case, discrete product features (such as overnight delivery, reliable supply and comparative costs, once the mainstays of the industry) are no longer considered sufficient, and a greater emphasis is placed on innovative solutions (Andersson & Norrman, 2002). These innovative solutions help customers achieve reliability levels high enough to enable inventory cost savings, and provide greater visibility and transparency throughout all aspects of the supply chain (DHL, 2004).

Managers are driven by the search for novelty and innovative customer solutions whenever a customized service is required. Innovative services are achieved by combining previously
unrelated capabilities (March, 1991), and new problem-solving approaches based on co-specialized assets (Lippman & Rumelt, 2003). This view incorporates the opportunity-recognition perspective associated with innovation, wherein managers seek to combine resources and capabilities in ways that create new learnings and relationships between corporate means and customer ends (Shane, 2012).

Operational capabilities can “create additional product market value by interacting with the firm’s current resource base through creating complementarities” (Schmidt & Keli, 2013 p. 211). The theory of complementarities — developed originally in economics to explain changes in modern manufacturing (Milgrom & Roberts, 1995) — argues that resources and capabilities reinforce each other to increase their marginal productivity (Devinney & Stewart, 1988; Collis & Montgomery, 1995). Complementarities are said to exist when “doing more of one thing increases the returns of doing more of another” (Milgrom & Roberts, 1995, p. 181). In other words, the synergies that arise when specific operational capabilities are combined exceed the value-creating capacity of each resource in isolation.

In a customized service setting, firms will place a premium on complementary operational capabilities because competitors find it hard to imitate the interactions between capabilities. These interactions are surrounded by causal ambiguity and structural complexity, enhancing the firm’s potential to differentiate the service offering and sustain a positional advantage. Thus, we propose:

P2: In customized service-oriented settings, managers will place greater emphasis on synergies between operational capabilities than they will in markets characterized by commodity services.
4 Research design and method

The domain used to test our propositions was the Asia Pacific management team of a major multinational logistics firm, which included representation from business units in Australia, New Zealand, Singapore, China, Hong Kong, India, Japan, South Korea, and Taiwan. The 3PL market is highly competitive, and contract bid teams routinely respond to tenders with major multinationals, amounting to hundreds of millions of dollars per year. During each tender preparation process teams of senior personnel from regional office and country subsidiaries come together to design the service delivery system that will provide the best chance of winning the contract, subject to the profitability requirements of the business.

Figure 2 illustrates the methodology applied. The subsections below provide detail on important aspects of each step. The core of the analysis is the discrete choice experiment conducted in Step 2. This is where we test our propositions. The discrete choice experiment is based on the mixture of capabilities underlying the “service concept scenarios” derived in Step 1. Step 3 represents a validation step where we show that the manipulation behind the discrete choice scenario is valid.

< Figure 2 here >

Step 1: Establish a representative model of the service concept scenarios

In Step 1 we undertook a multi-stage process to identify the customized and commoditized “service concept scenarios” as given in Appendix A. Alpha Corporation is representative of the “customized service” segment. It is a firm noted for innovation and flexibility and demands high levels of customer interaction, product/service recovery and proactive innovation from its suppliers. It is less concerned about price and capacity issues. Beta
Corporation is representative of the “commoditized service” segment. It is a firm noted for cost leadership and efficiency. For it, price is the dominant factor, with other concerns playing a secondary role, while supply chain innovation is immaterial.

The two scenarios are consistent with low cost/differentiation strategies (Porter, 1996), operational excellence, and customer intimacy value disciplines (Treacy & Wiersema, 1993). To add realism to the overarching manipulation used in Step 2, we obtained real request for quotation (RFQ) documents from large multinational companies. To ensure that the text in each scenario was consistent with a customized and commoditized service we used the results from a recent 3PL customer study conducted by Anderson et al. (2011).

Next, we needed to establish which capabilities were required to deliver the outcomes identified in each of the two representative service concept scenarios. Operationally, two different approaches were applied. First, 15 senior managers were interviewed (all interviews were recorded and transcribed). This was complemented with observation of the tender response processes and secondary data collection (for example, actual tender response documents), with the aim of developing an understanding of the contract bid response process. Based on these interviews, it was possible to determine the overarching sequential process for each competitive bid, which was: 1) establish a plan, 2) define the components that business unit representatives will work on, 3) collate responses, 4) price the work, 5) check the tender response for quality, and 6) deliver the pitch to the customer.

The second approach applied a thematic analysis to the recorded interviews and transcripts, observation notes and tender bid documents to identify the most important capabilities required for each service concept scenario. Because the tender review and bid preparation process relies heavily on information and knowledge integration between business units, we
draw on the theoretical work by Day (1994) on market-driven capabilities, and the knowledge integration mechanisms proposed by Grant (1996). Our interpretations of the data was validated by following the four-step process proposed by Hirschman (1986), where a priori definitions for all the capabilities were pretested and workshops were held with managers to ground interpretation in the tender bid response process. In addition, several presentations of our findings were made to the participating firm during the workshops to ensure that the scenarios proposed were realistic. This validation process helped to establish the validity of six capabilities used in the experimental manipulation (Step 2), both in terms of their distinctiveness and their definitions.

Table 1 presents the definitions of the six capabilities identified, which we label: active customer engagement (AE), cross-functional coordination (CF), innovation and creative solutions (CS), continuous operational improvement (OI), IT infrastructure (IT), and the professional delivery of the tender offer (PD).

Our propositions imply that good operating performance based on standardized or highly integrated processes is vital when the service is considered to be a non-differentiated or commoditized product. This demand structure will place an emphasis on operational improvement (OI) in processes based on standardization, and IT infrastructure (IT) that enables efficient information exchange across products, services and locations (Bharadwaj, 2000). Both operational capabilities generate efficiencies relative to the competition. Cross-functional coordination (CF) is central to organizing for process improvement and knowledge creation in operations management (Delbridge & Barton, 2002). However, in customized settings where intangible components matter, suppliers will direct attention towards more innovative solutions (CS) where higher levels of customer engagement are required (Chase,
1978) to ensure that client-specific needs are well understood. Table 1 illustrates the differences in capabilities levels, reflecting the importance and efficiency and standardization when commoditization is sought after and the need for capabilities to mold with client-specific needs when customized service demand is preferred.

< Table 1 here >

**Step 2: The service delivery system design trade-off**

In Step 2 we moved onto the discrete choice experiment (DCE), which allowed us to test our propositions formally. Specifically, the DCE was designed to measure the degree to which variations in the underlying capabilities would impact on the likelihood of the expected success of a bid (see Appendix B for the sample task).

The logic underlying this approach is based on the fact that any empirical assessment of the underlying capabilities necessary to support the commoditized-customized dichotomy cannot rely on customers only. This is so for both practical and cognitive reasons. First, customers are unlikely to be aware of, or even interested in, how service provider capabilities interact to yield the value they receive. Hence, the most appropriate sample of raters (or respondents) in a study such as this should include experienced service provider decision makers that frequently choose between different capability levels to identify the best service design configuration. Second, these managers rely on mental representations derived from their experience and training to determine the level of capability required for different service contexts. It has been shown that the mental representations held by skilled decision makers enable them to size up a situation quickly, to identify the way things interconnect and to determine what types of actions are appropriate (Lipshitz et al., 2001). These mental models, cognitive maps or causal maps are simplified representations based on combinations of
observation, intuition, and expertise (Klein, 1998) which enable managers to allocate resources in ways that align with different/heterogeneous service contexts.

The testing of the propositions via a DCE was conducted in line with established methods (see Louviere et al., 2000, for a detailed discussion). Managers were presented with 16 sets of four mixtures of capabilities as presented in Appendix B, with eight of the choice sets relating to each service concept scenario. Each capability had two levels (adequate and superior), as outlined in Table 1. Based on Step 1 in our research process, these two levels were viewed as appropriate because the firm felt that no provider would be offering services based on “inadequate” capabilities. Each capability was associated with an experimental attribute that was defined in the DCE. The design used to create the choice sets was based on a D-optimal design, where the resulting treatment combinations were presented to enable the collection of preference data (Louviere et al., 2000). The key advantage of this family of designs is that it minimizes the generalized variance of the resulting parameter estimates while providing sufficient data to enable the estimation of main effects and all two-way interactions. It also minimizes the number of choice tasks that the managers need to complete.

The managers task was to choose which of the options out of the four presented in each set was: 1) MOST likely to create a winning bid, or 2) LEAST likely to create a winning bid. These were our dependent variables in the logit estimation with the option representing MOST coded as +1, the option representing LEAST coded as -1, and the two non-chosen options coded as 0. This coding is equivalent to a partial ranking task.

Sample
Sixty-two managers completed the DCE. These individuals represent the majority of personnel responsible for designing tender responses for major TPL customers across the Asia
Pacific region. The sample size was established to fulfill the model specification and identification requirements of the experimental design completely.\(^3\) Fifty-four percent were female and 76 percent had completed a tertiary qualification. They were, on average, 34 years of age with a range of 22–46 years. To verify the expertise of the sample, individuals were asked to indicate if they had previously been involved in the selection of a particular transportation and logistics service provider. This binary YES/NO question is appropriate to establish response reliability where managers are required to assess the value of different operational capabilities in the tender review and bid preparation process (Sirmon et al., 2007). All respondents who answered YES to this question were included in the final analysis. Respondents were also asked to indicate their level of influence on the tender response and bid preparation strategy on a five-point semantic differential scale anchored with “no influence” and “maximum influence.” The average score of 3.1 also supports the appropriateness of the sample.

**Step 3: Establish the validity of the scenario manipulation**

The most important component of our analysis was the overarching “service concept scenario” manipulation that conditioned the DCE. Hence, it is critical that we establish the validity of this manipulation; in other words, to determine if the attributes used in the scenario manipulation were appropriate and that the service concept scenarios (that is, commoditized and customized service offerings) were perceived differently.

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\(^3\) Two factors imply that sample size is not an issue. First, the sample represents nearly every manager in the sample universe. Hence, a larger sample size was impossible. Second, the use of DCE with 16 choice options implies that we have considerable information on each manager, being able to characterize their decision models effectively, both in the aggregate and at the individual level.
Independence was measured using a set of hierarchical tests that estimated one model relative to the other across a range of scale factors. The full procedure is shown in Appendix C.

Results reveal that the test statistic for $\lambda_1$ is 57.47, with the point estimate of the scale factor ratio $\mu = 0.5$. Thus, $\lambda_1$ can be rejected, because it exceeds the critical value of 24.32. While this negates the need to test $\lambda_2$, it is noteworthy that this statistic is also rejected, with a value of 52.46. Together, these tests support the discriminant validity of the scenario-level treatment, providing for direct comparison of parameters between the two service concept models.

5 Results

The model used to analyze the DCE data is a variant of the conditional logit model, where the capabilities and their associated levels act as the independent variables, with the dependent variable being the preferred choice set that will maximize the likelihood of a tender bid being successful.

The DCE results in Table 2 provide output of the models for the aggregated, commoditized and customized service concept alternatives. The first proposition implies that managers facing scenarios where a commoditized service is desirable will utilize discrete capabilities (for example, standardization, efficient information integration) more intensively than managers facing scenarios where demand implies a more customized service. When faced with the commodity service scenario, all six capabilities were significantly associated with the arrangement of an attractive bid: AE, CF, CS, OI, IT, and PD. In contrast, in the differentiated service scenario, managers identified only three variables as significantly associated with bid success: AE, CS, and OI. The absence of any negative sign in the commodity service scenario
reveals a clear preference for superior over adequate capabilities in the commodity service context.

< Table 2 here >

The second proposition examines the importance of the interdependencies between capabilities, where we propose that the benefits accruing from the interaction between enhanced service capabilities will be more pronounced in the pursuit of a customized service offering. Nine of the fifteen possible interactions were significant in the customized scenario, while only one of the fifteen was significant for the commoditized scenario. In other words, when managers are required to respond to customer demands for innovative solutions they give more standing to the complementarities between capabilities. Therefore, Proposition 2 is supported, with the results revealing that managerial preferences for IT and CF depend on the level of complementary capabilities in CS, AE, and OI.

As an example, consider the benefits accruing from IT infrastructure, when a customized service concept is required. The interactions with active engagement ($\beta = 0.29, p < 0.05$), cross-functional coordination ($\beta = 0.46, p < 0.001$), innovative and creative solutions ($\beta = 0.21, p < 0.05$), operational improvements ($\beta = 0.35, p < 0.05$), and professional delivery ($\beta = 0.20, p < 0.05$) are all significant. The differences between models reveal that context plays a critical role in understanding the value of IT infrastructure. A similar result is visible with cross-functional coordination, where all five interactions are significant in the customized service; whereas all interactions in the commoditized service model are not significant.

Further useful descriptive statistics provided by the logit model are the odds-of-choice ratios (see Figure 3). These scores are a measure of effect size, describing the strength of association across the two levels for each capability in the study. For example, when a commoditized
service offering is required, there is a 245 percent increase in odds (p < 0.001) that managers will choose end-to-end solutions that are integrated and fast, and a 90 percent increase in odds (p < 0.001) that managers will choose a highly integrated IT infrastructure capability that covers regions and countries. However, when a differentiated service offering is required, there is a 195 increase in odds (p < 0.001) that managers will seek novel business solutions.

The greatest differences between models are found in the preference for integrated versus stand-alone IT infrastructure, the extent of collaboration across country and regional levels, and the scalability of end-to-end solutions. The results in Figure 3 provide confidence that the model is a valid representation of distinctive capabilities that managers consider necessary to support the two service offerings.

< Figure 3 here >

6 Discussion

This paper contributes to the core alignment proposition that forms the basis of the service strategy triad in service operations management (Roth & Menor, 2003) by providing an empirically grounded account of the alignment choices that managers make under different contextual settings. Despite the importance of resource allocation decisions to effective management within service-oriented firms such as Maersk, DHL, FedEx, and UPS, important questions about how and to what extent the mobilization of operational capabilities might vary have been rarely examined.

Our results serve as a basis for strengthening the empirical base of RBT by identifying the ex ante conditions under which managers attribute value to six distinctive operational capabilities. When a commoditized service is required, managers seek to compete on the basis of distinctive capabilities to leverage sub-additive cost synergies (Tanrivedi, 2006). In other
words, the ability to win a competitive bid arises from operational capabilities that are superior to the competition; if the capability is not scarce, it will not improve the firm’s relative advantage (Schmidt & Keil, 2013). When a differentiated or customized service is required, it is not necessary for all operational capabilities to be superior to competitors. Instead, the value of operational capabilities (such as IT and CF) depends on the value of other spanning capabilities (such as CS, OI, and AE). By interacting with the firm’s current operational capabilities, complementarities are generated that provide new sources of value (Wernerfelt, 2011). In other words, super-additive value synergies (Tanrivedi, 2006) are sought where IT infrastructure and CF coordination capabilities interact with other capabilities to increase their joint value: \( \text{value}(a, b) > \text{value}(a) + \text{value}(b) \).

Defining the specific operational capability levels required for different services provides for sharper differentiation than has been previously reported in the service operations literature (Karwan & Markland, 2007). For example, the results provide managers with a deeper understanding of how firms combine and recombine resources to align their supply strategy with product and service characteristics. The fine-grained assessment of operational capabilities discussed here is consistent with work in the management literature (e.g., Miller & Shamsie, 1996) showing that property-based resources (such as long-term contracts with movie stars and theatres) are more valuable in stable environments, while knowledge-based resources in the form of production and coordinative talent are more valuable in uncertain (changing and unpredictable) environments. This study suggests that efficient information integration based on standardized procedures is more valuable in commodity service contexts and complementarities that enhance service innovation are more valuable in customized service contexts.
Until recently the role of managers and their decisions have been largely absent from the RBT. However, while this trend is being moderated by recent conceptual advances (Adner & Helfat, 2003; Helfat et al., 2007; Sirmon & Hitt, 2009; Sirmon et al., 2011) further study is warranted (Crook et al., 2008). In this vein, our study makes an important empirical contribution by drawing on a choice-theoretic methodology to unpack management decisions and using the information gleaned from that analysis to determine how managers choose to compete during the tender response process. For example, at the aggregate level (see Table 2), our research supports the basic proposition found in the business press that general-purpose infrastructure technologies (such as railroads, plumbing and electricity, and IT infrastructure) do not generate competitive advantages because they are both common and replicable (Carr, 2003, p. 5). However, when the two-segment model is taken into account — based on a more sophisticated analysis that distinguishes between commoditized and differentiated service offerings — the results reveal that general purpose infrastructure technologies such as IT are critically important to positional advantage.

Resource-based theory has been criticized by many scholars for its definitional ambiguity (Foss, 1997) and circular logic, where successful firms are so because they have unique resources (Powell, 2002). This study addresses some of the shortcomings in RBT by identifying the specific levels of operational capabilities (i.e., a particular resource type) that are necessary for commoditized and customized service settings. The results reveal that knowing more accurately the relative value of different levels of operational capabilities is at least as important as possession of better operational capabilities. By shedding new light on how interactions between operational capabilities matter, the study builds on and extends a small body of work, which has investigated resource complementarities (see, e.g., Powell & Dent-Micallef, 1997; Coltman et al., 2011a) and value synergies (Barua & Whinston, 1998).
These findings are important to service operations and innovation research (Dewett & Jones, 2001) because they reveal that when capabilities are tightly linked they create complexity, ensuring that any imitation is both challenging and time consuming. Even if competitors understand the technical nature of each capability, they will find it difficult to decipher the proper sequence in which it is deployed, creating unexpected combinatorial effects. Finally, the results add to the literature regarding the effective orchestration of capabilities (Sirmon & Hitt, 2009; Sirmon et al., 2011) by demonstrating “a high order of integrative capacity” (Lawrence & Lorsch, 1967, p. 245) that managers possess. This higher-order capability to align the right service offering to the right customer appears to pass the resource-based view of the firm test; becoming a valuable rent-producing resource that is scarce, inimitable, and non-substitutable (Barney, 2002).

Understanding how managers attribute value to those operational capabilities that will increase their ability to win a competitive bid helps us gain an understanding of what is required to improve operational performance. An important benefit of the experimental DCE methodology used in this study is that it aligns closely with actual choice behavior and avoids the well-documented biases inherent in alternative methods such as ratings (Lenk & Bacon, 2008). Although prior operations management research has identified that cost, quality, delivery, and flexibility are important (Schroeder et al., 2002), we know little about what level of operational capability is required or what additional operational capabilities drive managerial choices. The use of DCE allows researchers to address this issue in two ways. First, because of the attention paid to both attributes of a decision and the levels of the attributes, we can determine both which attributes are important and how that importance varies with the level of those attributes. Second, because DCE “does not force subjects to place answers on scales that are inconsistent with the ‘natural’ decision processes used by
managers,” it “offers greater control over alternative explanations” (Richard et al., 2012, p. 88). Hence, using a properly designed choice experiment enables operations management researchers to design, collect, and assess the impact of complex operational trade-offs in new ways that is of value both practically — in telling managers how to optimize — and academically — in helping scholars rule out alternative theoretical explanations of phenomena.

In addition, although panel and survey studies can reveal statistically determined relationships between practices (such as total quality management, lean manufacturing, or vertical integration) and performance, the actual resource orchestration choices that managers make are treated as a black box. The variance that exists is assumed to be between firms, while the managers within a firm are assumed to be homogeneous or randomly different. Drawing on discrete choice experimental methods — based on organizationally relevant scenarios and controlled decision tasks — we provide an alternative perspective that more directly measures the inner workings of the managerial black box. Specifically, we measure the resource configuration choices that individual managers make when responding to a customized and commoditized service requirement. The relevant question here is not “How much does the practice matter?”, but “Which specific operational capabilities are required?”. Furthermore, we provide a level focus, whereby attention is given to the particular levels within each operational capability. The relevant question here is “What level of operational capability will provide the best chance of success?”. Hence, our study complements more traditional practice-performance research in operations management that has identified various drivers of high performance (Ketokivi & Schroeder, 2004) by revealing the extent to which heterogeneity exists below the level of the firm.
This work is important because it brings the manager back into the service operations equation. By concentrating on the role of the service operations manager as a decision maker about what operational capabilities need to be built and deployed (Sirmon et al., 2007), we reveal an important source of variance in service outcomes. Hence, we show that managers matter in the sense that they are simply not machines executing a firm level model. By doing this we shed new light on a key question in RBT by explaining how organizations end up orchestrating the resources and operational capabilities in their possession to create superior value (Maritan & Peteraf, 2011; Schmidt & Keil 2013). As Zomerdijk and de Vries (2007) state, a starting point for future research in service operations is the empirical consideration of the service design choices that managers actually make.

7 Limitations and directions for further research

In writing about the theory building process, Weick (1979) cautions that theories developed to explain human activities cannot be generalizable, while they simultaneously offer high levels of accuracy and simplicity. Service design is a complex human activity, and this study sacrifices breadth for high levels of accuracy and simplicity. Thus, a limitation of this study is that the results do not necessarily offer broad applicability beyond the contract logistics population from which the sample of customers and supplier managers were drawn. This is true of all resource- and capability-based theories where “the actual effect size of a particular resource is context dependent” (Armstrong & Shimizu, 2007, p. 977) and further research is required to confirm the generalizability of these results. Despite this limitation, the constructs used in this study exhibit a high degree of applicability to many industries (Tanriverdi, 2006).

Bendoly et al., (2006) state that the success of operations management and the accuracy of its theories rely heavily on an understanding of human behavior. The power of experimental
approaches is that they provide a clearer and more complete picture of a manager’s decision calculus. Although many scholars believe that it is reasonable to forecast/predict market outcomes from experimental scenarios (McFadden, 1986), all stated preference techniques suffer from the limitation that managers (and customers) may not behave as they reveal they will in experiments (Lovallo & Sibony, 2010). Thus, we make no claim to model the actual success of the 3PL tender process because customers (not managers) determine the value in a service exchange (Vargo & Lusch, 2004). It is important to note, however, that the managers sampled in this study represent a global market leading 3PL firm, and that anecdotal evidence exists to indicate that the systematic alignment of internal operational capabilities with distinct buyer behavior structures has led to improved performance (Coltman et al., 2010; 2011b). This work allows us to speculate that the sample of managers studied are able ex ante to make better choices concerning the level of operational capability required to create and capture value and that these choices should be close to the ex post realized resource value as determined by the customer.

Future work should seek to validate this claim, and we urge researchers to continue to explore new experimental approaches that allow scholars to unpack the performance implications of resource orchestration decisions in controlled ways. Further, the tender review and bid response process is increasingly common and worthy of further investigation to evaluate the generalizability of the results across a wider range of companies and industries. The design literature offers another perspective that is worthy of greater investigation because it is directly concerned with the way managers draw on associations and analogies to build up a “prediction” for what might work (Romme, 2003).
8 Conclusion

The need to match supply with demand has gained a prominent position in the service operations (Roth & Menor, 2003) and the wider operations management (Cachon & Terwiesch, 2012) literatures. However, the role that managers play in the alignment process has been rarely investigated. This is critical because, if managers do matter, as the management literature indicates, then methodologically they are a “source of variance” that needs to be taken into account, irrespective of the empirical modeling used.

This study makes two contributions by empirically capturing the way managers orchestrate operational capabilities to better align with a customized and commoditized service requirement. First, the results show how two understudied areas of operations management — the role of managers in bundling operational capabilities (Sirmon et al., 2011) and the role of alignment that forms the basis of the service strategy triad (Roth & Menor, 2003) — can be fruitfully combined to gain new insights into how firms compete during the tender review and bid preparation process. Second, from a methodological perspective, following on from work of Mantel et al. (2006), Garver et al. (2012), and others, we provide additional evidence about the importance of stated preference methods for examining operational management issues.

Acknowledgements

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References


Appendix A: Experimental scenarios

Customized scenario: Alpha Corporation

[Image]

Commodity scenario: Beta Corporation

[Image]
### Appendix B: Sample DCE task

<table>
<thead>
<tr>
<th></th>
<th>Option 1</th>
<th>Option 2</th>
<th>Option 3</th>
<th>Option 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active engagement</td>
<td>Adequate</td>
<td>Superior</td>
<td>Superior</td>
<td>Superior</td>
</tr>
<tr>
<td>Cross-functional coordination</td>
<td>Superior</td>
<td>Adequate</td>
<td>Adequate</td>
<td>Superior</td>
</tr>
<tr>
<td>Creative solutions</td>
<td>Adequate</td>
<td>Superior</td>
<td>Superior</td>
<td>Adequate</td>
</tr>
<tr>
<td>Operational improvement</td>
<td>Superior</td>
<td>Superior</td>
<td>Superior</td>
<td>Adequate</td>
</tr>
<tr>
<td>IT infrastructure</td>
<td>Superior</td>
<td>Adequate</td>
<td>Superior</td>
<td>Superior</td>
</tr>
<tr>
<td>Professional delivery</td>
<td>Superior</td>
<td>Superior</td>
<td>Adequate</td>
<td>Superior</td>
</tr>
</tbody>
</table>

1. Which option is MOST likely to create a winning bid *(Please tick one only)*

   □ □ □ □

2. Which option is LEAST likely to create a winning bid *(Please tick one only)*

   □ □ □ □
Appendix C: Manipulation check on customer scenarios

In order to draw comparisons between the attributes and across groups, we generated odds ratios, which act as comparable effect sizes, and show the relative impact of the variables across experimental groups. An odds ratio is the ratio of the odds of an event occurring in one group to the odds of it occurring in another group. The application of this technique led to the generation of odds ratios under each of the two scenarios, each representing the odds of selecting an option when being presented with an attribute at one of its two levels.

Odds ratios can be calculated from the coefficients of a logistic regression. If we regress Y on X, then the estimated coefficient \( \hat{\beta}_x \) for X is related to a conditional odds ratio:

\[
e^{\hat{\beta}_x} = \frac{P(Y = 1|X = 1, Z_1, \ldots, Z_p)/P(Y = 0|X = 1, Z_1, \ldots, Z_p)}{P(Y = 1|X = 0, Z_1, \ldots, Z_p)/P(Y = 0|X = 0, Z_1, \ldots, Z_p)}
\]

where Y is a binary response variable and X is a binary predictor variable. We also have other predictor variables \((Z_1, \ldots, Z_p)\), which may or may not be binary. \(e^{\hat{\beta}_x}\) is the estimate of the conditional odds ratio; that is, \(e^{\hat{\beta}_x}\) is as an estimate of the odds ratio between Y and X when the values \(Z_1, \ldots, Z_p\) are held fixed. Although attribute coefficients from choice analysis are standardized by the experimental design, it was also necessary to assess whether the impact of random variance across groups may have led to misspecification of systematic variance. Here, we again applied the model equivalence calculations.
We assessed the validity of the group level manipulation by the set of hierarchical tests, as outlined in Louviere et al. (1993). This aims to determine if the scenario manipulation presented two distinct customer-demand scenarios (where Alpha Corporation presents a differentiated customer scenario, and Beta Corporation presents a commoditized customer scenario).

The evaluation of model equivalence was done by estimating one model relative to the other across a range of scale factors. To examine model equivalence, we calculated the likelihood ratio test statistic using the following formula:

\[ \lambda_1 = -2[L_\mu - (L1 + L2)] \]  

where \( L_\mu \) corresponds to the log likelihood with the estimate of the scale factor ratio (\( \mu \)).

This scale factor ratio is a simple multiplier that optimally scales the parameter estimates for the second model relative to the first, providing for direct comparison of parameters between the two group-specific models. \( L1 \) and \( L2 \) correspond to the log likelihood estimates for the separate models (that is, exploration and exploitation). The test statistic is asymptotically \( \chi^2 \) distributed with \((K + 1)\) degrees of freedom, where \( K \) is the number of parameters in the model. If this test statistic is not rejected, it is then necessary to determine whether this equivalence is due to the scale factor. To achieve this, we estimated a test statistic using the following formula:

\[ \lambda_2 = -2[Leq - L_\mu] \]  

where \( Leq \) corresponds to the joint log likelihood value when the scale factor for both models is fixed at 1. The test statistic is once again asymptotically \( \chi^2 \) distributed with \((K + 1)\) degrees of freedom. In our case, the test statistic for \( \lambda_1 \) of 57.47 leads to the rejection of the null hypothesis of model equivalence (it exceeded the critical value of 24.32). While this negates
the need to test \( \lambda_2 \), it is noteworthy that the statistic of 52.46 also supports the rejection of equivalence. Together, these tests support the discriminant validity of the group-level treatment.
Figure 1. Tender review and bid preparation process: Basis of critical process spanning capabilities
| Establish a representative model of the service concept scenarios | **Step 1:** Establish representative model of customer market structures. Review the literature to identify two representative service value disciplines based on customized and commoditized service offerings. Identify capabilities required to create customer value for each segment identified above. Detailed pre-testing to identify important capabilities in tender bid response processes.  
Part A:  
Interview senior managers (20 interviews).  
Map bid response process flow.  
Complete thematic analysis.  
Part B:  
Compete quality function deployment exercise (15 managers).  
Compare to prior case examples based on Apple and Lenovo. |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Alignment trade-off</td>
<td><strong>Step 2:</strong> The service delivery system design trade-off. Conduct discrete choice survey (62 managers). Examine direct effects and two-way interactions. Complete demographic analysis on respondents.</td>
</tr>
<tr>
<td>Discriminant validity check</td>
<td><strong>Step 3:</strong> Establish validity of scenario manipulation. Complete hierarchical tests. Compare models to develop support for discriminant validity.</td>
</tr>
</tbody>
</table>

**Figure 2. Methodological steps and data gathering process**
Note: The odds ratio (y-axis) is a measure of effect size, describing the strength of impact for each operational capability. All values are percentages. The operational capabilities are shown on the x-axis. To avoid confusion we display the line values for the aggregate model only.

**Figure 3. Impact on odds of choice for each capability**
<table>
<thead>
<tr>
<th>Capability</th>
<th>DCE attribute and definition</th>
<th>Capability levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active engagement</td>
<td>Active customer engagement: this captures the depth of pre-work undertaken to understand customer priority areas and engage with the customer.</td>
<td>Superior: Conducts numerous customer visits to obtain feedback, agree on the best approach and build relationships. Adequate: Rarely contacts the customer directly and typically requires minimal information.</td>
</tr>
<tr>
<td>Cross-functional coordination</td>
<td>Cross-functional coordination: leadership capability to coordinate the effort of individuals within the bid team and motivate participation at both country and regional levels.</td>
<td>Superior: Draws on a culture of collaboration to leverage knowledge and skills across country and regional levels. Adequate: Rarely collaborates with stakeholders outside of the country in which company resides.</td>
</tr>
<tr>
<td>Creative solutions</td>
<td>Creative business solutions: the ability to create innovative customer solutions based on an ability to acquire, assimilate and use knowledge.</td>
<td>Superior: Understands and uses detailed customer data to find novel business solutions. Adequate: Offers standard solutions with only incremental improvements.</td>
</tr>
<tr>
<td>Operational improvement</td>
<td>Continuous improvement in operations: the ability to make sustained incremental improvements in on time and error free delivery, often involving the standardization procedures.</td>
<td>Superior: Able to design scalable end-to-end solutions that are integrated and fast, and that provide increased capacity. Adequate: Bases improvement initiatives on irregular, ad hoc problem solving.</td>
</tr>
<tr>
<td>IT infrastructure</td>
<td>IT infrastructure: the ability to leverage corporate-wide IT systems to share information across products, management services and locations.</td>
<td>Superior: Able to draw on a common IT infrastructure that ensures high visibility across all activities. Adequate: Able to draw on stand-alone IT infrastructure modules resident within each country, region and global HQ.</td>
</tr>
<tr>
<td>Professional delivery</td>
<td>Professional delivery: the ability to articulate the bid proposal details (what, why and how the bid delivers on RFQ requirements) during the bid pitch.</td>
<td>Superior: Able to provide clarity in presenting and give clear examples that demonstrate customer value. Adequate: Provides a more generic pitch about the bid.</td>
</tr>
</tbody>
</table>

Note: two level items were coded as +1 and -1. The superior capability is coded as +1 and the adequate capability is coded as -1.
Table 2. DCE results

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Aggregate Beta</th>
<th>z-value</th>
<th>Aggregate Beta</th>
<th>z-value</th>
<th>Aggregate Beta</th>
<th>z-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active engagement (AE)</td>
<td>0.50</td>
<td>6.22</td>
<td>0.46</td>
<td>3.50</td>
<td>0.43</td>
<td>3.88</td>
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<tr>
<td>Cross-functional coordination (CF)</td>
<td>0.20</td>
<td>2.49</td>
<td>-0.21</td>
<td>-1.60</td>
<td>0.37</td>
<td>3.42</td>
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<tr>
<td>Creative solutions (CS)</td>
<td>0.59</td>
<td>7.28</td>
<td>0.68</td>
<td>5.06</td>
<td>0.49</td>
<td>4.54</td>
</tr>
<tr>
<td>Operational improvement (OI)</td>
<td>0.67</td>
<td>8.24</td>
<td>0.36</td>
<td>2.81</td>
<td>0.80</td>
<td>7.20</td>
</tr>
<tr>
<td>IT infrastructure (IT)</td>
<td>0.14</td>
<td>1.72</td>
<td>-0.25</td>
<td>-1.96</td>
<td>0.37</td>
<td>3.40</td>
</tr>
<tr>
<td>Professional delivery (PD)</td>
<td>0.32</td>
<td>4.08</td>
<td>0.18</td>
<td>1.40</td>
<td>0.37</td>
<td>3.44</td>
</tr>
</tbody>
</table>

Interaction effects

<table>
<thead>
<tr>
<th>Interaction</th>
<th>Aggregate Beta</th>
<th>z-value</th>
<th>Aggregate Beta</th>
<th>z-value</th>
<th>Aggregate Beta</th>
<th>z-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CF x AE</td>
<td>0.02</td>
<td>0.33</td>
<td>0.20</td>
<td>2.04</td>
<td>-0.05</td>
<td>-0.57</td>
</tr>
<tr>
<td>CF x CS</td>
<td>0.03</td>
<td>0.55</td>
<td>0.10</td>
<td>2.00</td>
<td>0.00</td>
<td>0.04</td>
</tr>
<tr>
<td>CF x OI</td>
<td>0.05</td>
<td>0.89</td>
<td>0.20</td>
<td>2.05</td>
<td>0.00</td>
<td>0.04</td>
</tr>
<tr>
<td>CF x IT</td>
<td>0.14</td>
<td>2.32</td>
<td>0.46</td>
<td>4.55</td>
<td>-0.03</td>
<td>-0.34</td>
</tr>
<tr>
<td>CF x PD</td>
<td>0.06</td>
<td>0.91</td>
<td>0.28</td>
<td>2.83</td>
<td>-0.03</td>
<td>-0.40</td>
</tr>
<tr>
<td>IT x AE</td>
<td>0.10</td>
<td>1.60</td>
<td>0.29</td>
<td>3.00</td>
<td>0.02</td>
<td>0.21</td>
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<tr>
<td>IT x CS</td>
<td>-0.03</td>
<td>-0.41</td>
<td>0.21</td>
<td>2.15</td>
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<td>-2.11</td>
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<tr>
<td>IT x OI</td>
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<td>0.95</td>
<td>0.35</td>
<td>3.53</td>
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<td>-1.85</td>
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<tr>
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<td>0.02</td>
<td>0.38</td>
<td>0.20</td>
<td>2.06</td>
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<td>-1.00</td>
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<tr>
<td>AE x CS</td>
<td>0.20</td>
<td>3.27</td>
<td>0.43</td>
<td>4.23</td>
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<tr>
<td>AE x OI</td>
<td>-0.04</td>
<td>-0.69</td>
<td>0.05</td>
<td>0.49</td>
<td>-0.02</td>
<td>-0.23</td>
</tr>
<tr>
<td>AE x PD</td>
<td>0.10</td>
<td>1.57</td>
<td>0.12</td>
<td>1.21</td>
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<td>CS x OI</td>
<td>-0.10</td>
<td>-1.67</td>
<td>-0.01</td>
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<td>-0.13</td>
<td>-1.56</td>
</tr>
<tr>
<td>CS x PD</td>
<td>0.06</td>
<td>1.00</td>
<td>0.19</td>
<td>1.92</td>
<td>0.02</td>
<td>0.19</td>
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<tr>
<td>CI x PD</td>
<td>0.00</td>
<td>-0.01</td>
<td>0.13</td>
<td>1.36</td>
<td>-0.05</td>
<td>-0.57</td>
</tr>
</tbody>
</table>

R(0)^2     | 0.31           | 0.47    | 0.25           | 0.25    |
-2LL        | 817            | 671     | 971            | 971     |

Note: Shaded cells represent highly significant results (p<0.05).