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Casual observation suggests that firms use contrasting practices and procedures when offering customized products to individual customers. Some firms take a "hands-off" approach and let customers self-select their desired product. In contrast, other firms are proactively involved in designing customized solutions to individual customer needs. The authors call the former "low vendor customization control" and the latter "high vendor customization control." Despite the strategic importance of customization, no research has shed light on the rationale for using these contrasting approaches to customization and their normative consequences. The authors develop a conceptual model that contends that the appropriate level of vendor control over the customization decision is a function of technology and knowledge considerations. They use data on 304 procurement arrangements for customized products to test their hypotheses and to explore the normative ramifications for three key measures of performance: closeness of the delivered product to customer needs, delivery performance, and the vendor's operating profits. The results show that contracting parties choose the level of vendor control over customization in a strategic and discriminating way to enhance the benefits from customization for both parties. The authors discuss implications for both theory and practice.

Customizing Complex Products: When Should the Vendor Take Control?

Vendors of complex products often offer customized solutions to potential buyers (Gilmore and Pine 1997; Wuyts et al. 2004). Customization is of strategic value to firms because it allows a better match between a firm's offerings and customer needs and preferences, fosters customer loyalty, and potentially translates into increased firm profits and delivery performance (Fornell et al. 1996; Perdue and Summers 1991). The growing popularity and importance of this topic is reflected in the academic literature on customization, which falls into two research streams. The first stream focuses on developing optimizing algorithms based on data obtained from self-reported preferences (e.g., Ansari and Mela 2003), prior behavior (Rossi, McCulloch, and Allenby 1996), or experimental setups (Leichty, Ramaswamy, and Cohen 2001) to generate customized recommendations and content based on these preferences. The second stream focuses on the role of complexity of customization interfaces and processes and the effect of such format presentations and processes on customer evaluation (e.g., Dellaert and Stremersch 2005; Huffman and Kahn 1998).

However, these research streams mainly focus on customization in business-to-consumer environments and are silent on key features of customization in business-to-business markets. For example, observation of customization practices in business-to-business settings show radically different approaches to customization. Specifically, many firms (e.g., in the personal computer industry) preselect the range and "granularity" of interoperable components, develop a customization interface, and let individual customers have control over composing their desired product without input from the vendor. In contrast, in other markets, many customers rely exclusively on the vendor to develop appropriate solutions; consequently, in such markets, vendors have more control over customization and choose the specific product composition for the customer. Such proactive vendor control and effort toward customization has been observed in various contexts, including inventory management and control systems (Anderson and Narus 1998), complex industrial systems and components (Ghosh and John 2005), services provided to the retail industry

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(Gilmore and Pine 1997), and electronics and telecommunication systems (Jap and Mohr 2002). Similar contrasts in organization can be observed in e-customization settings, in which some Web sites offer customer-initiated, on-site customization and others offer company-initiated, on-site customization (Ansari and Mela 2003). Ansari and Mela (2003), however, take these format choices as given and develop optimizing algorithms that customize offerings.

The striking contrast in the organization of customization practices in industrial markets raises two key unanswered questions we aim to answer in this article. First, how much control does the vendor have over customization decisions, and when does the vendor leave more of these decisions to its customers? Understanding this issue is of strategic value because a firm's ability to modulate the level of control it exercises in a customer relationship can influence the effectiveness of its customized solutions. Our conceptual model treats these contrasting forms of customization as alternative marketing institutions. On the basis of the rationale of the Coase theorem (Coase 1960) and the efficiency criterion (Wernerfelt 1994a), our model contends that parties in a vertical trading relationship, with a given set of antecedent conditions, choose the institution that provides higher net joint gains. We incorporate both vendor and customer characteristics to show how two sets of specific antecedent conditions—namely, technology and knowledge factors—influence the customization control choice of the contracting parties.

Second, if the extent of vendor control over customization activities is indeed a strategic choice, what is its impact on the purported goals of customization, namely, the successful delivery of products that match customer needs and preferences in a profitable way? Substantively, understanding the "appropriate" structure for customization is important because costly marketing actions (e.g., the training and design of the sales force and its activity sets, customer-side prospecting and information dissemination programs, structuring of supply-side arrangements for appropriate components) must fit the chosen organization of customization if firms want to take their products to market successfully. Specifically, we examine the normative impact on three key outcome measures: closeness of the delivered product to customer needs, delivery performance, and the vendor's operating profits. Because it is assumed that contracting parties consider these objectives explicitly when choosing the level of vendor control, we use selection-correction estimation techniques (e.g., Garen 1984, 1988; Heckman 1979) to achieve this goal.

We study both questions in a context in which vendors sell customized industrial systems to specific customers. Given this focus, we preclude settings in which the vendor supplies a noncustomized (i.e., standardized) product. Our theory and analysis is at an individual procurement contract level. We analyze primary survey data obtained from 304 procurement contracts from vendors of complex, industrial products to test our hypotheses. Empirical tests provide support to the theory and suggest that the level of vendor control in customization is indeed a strategic variable. In accordance with the efficiency rationale, firms seem to choose the level of vendor control over customization with a focus on enhancing the benefits/gains from such efforts to both parties. In this sense, the observed organization of customization practice reflects a "win–win" strategic choice on the part of the contracting parties. Together, these results suggest that vendors should delegate or undertake proactive effort toward customization in a discriminating way.

We organize this article as follows: In the next section, we provide the conceptual background for our focal dependent variable—that is, customization control—and present our conceptual framework. We then offer our research hypotheses. This is followed by our empirical study and the results. We conclude with a discussion of our findings and their implications for research and practice.

CONCEPTUAL FRAMEWORK

Customizing complex products requires decisions about specifying product attributes that closely match customer needs and designing the product architecture that specifies the features of and interfaces between the product's component parts (Sanchez and Mahoney 1996). These decisions can be made by the buyer or delegated to the vendor, or they can be the product of a joint decision-making process between the two parties (Heide and John 1990). We use the term "customization control" to indicate the extent to which the vendor has control over the composition of the customized product in a particular customer relationship. A high level of customization control means that the vendor undertakes a detailed analysis of customer needs and translates them into specific solutions by designing the complex product specifically to the customer's requirements, mixing and matching components to the customer's needs, and putting the customized and complex product together. Likewise, a low level of customization control means that the customer primarily undertakes a detailed analysis of his or her own needs and translates these into specific solutions without significant assistance of the vendor.[1] Note that regardless of the level of control the vendor exercises in a customization decision, the incidental task of physically assembling and installing the system into a working unit is usually done by the vendor. Thus, our question pertains only to the control of one party or the other over the attributes of the system's final composition, not its assembly or installation. Our core thesis is that parties strategically choose the level of customization control to enhance the performance outcomes from the relationship.

What are the determinants of customization control? We contend that in complex markets, the appropriate level of customization control is influenced by features of the underlying technological and knowledge considerations. Technological features are critical because the ease with which feasible solutions can be constructed depends on the extent to which the constituent subparts (i.e., components) are standardized and can be easily configured and the extent to which future technology developments can be predicted. In general, the former is referred to as "modularity" (Sanchez 1999) and the latter as "technological unpredictability" (Walker and Weber 1984). Composing a complex, customized product is more difficult and resource intensive when the modularity is low and the technological unpredictability is high.

The knowledge base of the contracting parties is critical because composing a complex, customized product puts

[1]Note that "control" in our setting is distinct from the behavior control and outcome control mechanisms espoused in agency theoretic frameworks.

specific demands on customer knowledge and the flow of knowledge through the channel (Wuyts et al. 2004). Thus, critical to the customization of complex products is the product- and category-specific knowledge of the buyer (Quinn, Baruch, and Zien 1997; Stremersch et al. 2003) and the resources the vendor has developed to understand customer needs and incorporate that knowledge for generating solutions. We call these vendor resources "vendor's customer knowledge mobilization resources." Composing a complex, customized product is more difficult and resource intensive when the customer knowledge and the vendor's customer knowledge mobilization resources are low.

In summary, the ease with which the buyer or the vendor can compose complex, customized products is influenced by key technology and knowledge considerations. The efficiency-based perspective would then contend that the level of vendor control over customization that the contracting parties choose is one that provides net benefits/gains to both parties. Wernerfelt (1994a) illustrates the utility of the principle in a wide variety of vertical trading situations. In our specific context, we now turn to the task of showing how technology and knowledge factors differentially influence the ease with which either the vendor or the buyer can customize the product and the influence on the customization control decision.

RESEARCH HYPOTHESES

Technology Considerations

Modularity. Modularity refers to the degree to which the interfaces between functional components are standardized and specified to allow the substitution of components without requiring changes to the design of other components (Sanchez 1999). If modularity is low, a particular component's features cannot be altered or improved on without making special modifications to the design of other components (John, Weiss, and Dutta 1999; Sanchez 1999). Typically, in such cases, interfaces are specified in proprietary ways (Wilson, Weiss, and John 1990). Because product features depend on one another and because interfaces are proprietary, the complexity and uncertainty inherent in customization activities are much higher when modularity is low than when it is high. When facing complex and uncertain situations, decision makers often react by gathering more information about the decision at hand (Nutt 1984; Weiss and Heide 1993). However, there is a strong asymmetry between buyer and supplier as to the extent to which this is possible. For example, when modularity is low, the supplier has much better knowledge than the buyer on the specification of proprietary interfaces between components. Thus,

H_1: The lower the modularity, the higher is the vendor's customization control.

Technological unpredictability. Technological unpredictability refers to the inability to predict accurately the technological evolution in the focal product category (Bensaou and Anderson 1999; Walker and Weber 1984). We contend that decision makers can adapt to high levels of technological unpredictability by purposively structuring decision-making processes (Bourgeois and Eisenhardt 1988). If technological unpredictability is high, the buyer faces a problem in composing a customized, complex product. Because future technologies are difficult to predict, the buyer should increase his or her search and acquisition of information. However, at the same time, building such knowledge becomes more costly and less valuable to the customer as the environment becomes more unpredictable because a shift in technology becomes more likely, which would destroy any knowledge the customer has built (Tushman and Nelson 1990). Conversely, in such markets, vendors often prefer having a high level of control over the specification of the customized product because it enables them to meet customer needs better and also gain important experience to improve their own technological platform to have a much wider appeal (Rosenberg 1976). Thus,

H_2: The higher the technological unpredictability, the higher is the vendor's customization control.

Knowledge Considerations

Customer knowledge. Customer knowledge refers to the buying organization's degree of expertise, experience, training, and competence in the focal product category (Quinn, Baruch, and Zien 1997; Stremersch et al. 2003). Buyer knowledge is critical in complex markets (Glazer 1991) for two reasons. First, expert buyers have an accurate assessment of their own needs (Heide and Weiss 1995; Polanyi 1962) and are capable of transferring their manifest and tacit needs into appropriate product attributes. Their tacit needs may not be easily transferred to an outside party (Hansen 1999). In contrast, nonexpert buyers can have difficulty in evaluating different configurations of complex products (Wernerfelt 1994b). Second, expert buyers can more easily sort through the offered product-attribute space (Anderson, Chu, and Weitz 1987), are more capable of analyzing information (Alba and Hutchinson 1987), and can more easily choose product configurations that best meet their needs (Weiss and Heide 1993) than can nonexpert buyers. As such, expert buyers require lower levels of input from the vendor in choosing the product's features that match their needs. Thus,

H_3: The higher the buyer's knowledge, the lower is the vendor's customization control.

Vendor's customer knowledge mobilization resources. We define the vendor's customer knowledge mobilization resources as the procedures and structures the vendor has put in place to absorb customer knowledge and generate customized solutions.[2] These resources can be firm-specific and nonimitable (Lippmann and Rumelt 1982; Mahoney and Pandian 1992) and thus can have rent-generating potential (Wernerfelt 1984). Firms can proactively develop resources (e.g., organizationwide procedures, systems, policies) that ensure that knowledge is shared and integrated throughout the supply chain. These resources can include the development of cross-functional teams and intra- and

[2]Our customer knowledge mobilization resource construct is distinct from the popular market orientation construct (Kohli and Jaworski 1990; Kohli, Jaworski, and Kumar 1993) in two ways. First, our construct has a narrower focus on designing and developing customized solutions, whereas market orientation refers to organizationwide generation, dissemination, and responsiveness on a broader set of issues, including competitive actions, sales, service, product failures, customer complaints, and so forth. Second, our construct addresses specific structures and procedures that are put in place to enable customized offerings; this is absent from the market orientation construct.

interfirm linkages that enable the vendor to understand the "value drivers" for the customer, integrate that information, and adapt its product configurations while providing customized solutions. The vendor can set up a system that creates an "organizationwide memory" of prior experiences, both successful and unsuccessful, that are shared between functional groups and enable it to craft better solutions (Nelson and Winter 1982; Polanyi 1962). The vendor can also set up supplier-side couplings for inventory management and involve its own suppliers early in the product design stages (Frazier, Spekman, and O'Neal 1988).

The mobilization of such resources is likely to enable the vendor to develop solutions/applications that enhance the customer's manufacturing, marketing, logistics, and engineering processes (Anderson and Narus 1998). Vendors that have well-developed customer knowledge mobilization resources as a result of accumulated knowledge and learning (Winter 1987) are better able to understand tacit and idiosyncratic customer needs and translate them into customized products in a cost-effective way. They are also better able to mobilize resources from other channel members in designing a new customized solution for the customer or adjusting individual components of the customized product (Wuyts et al. 2004). Thus,

> H_4: The better developed the vendor's customer knowledge mobilization resources, the higher is the vendor's customization control.

We further contend that a high level of customer knowledge mobilization resources enables a vendor to modulate the level of control in accordance with the contextual needs of a particular customer relationship. Thus, we predict substantial interaction effects between vendor customer knowledge mobilization resources and (1) modularity, (2) technological unpredictability, and (3) customer know-how.

Interaction with modularity. H_1 proposed that lower levels of modularity would increase vendor control over the customization decision. The reason is that lack of modularity creates uncertainty about the interdependence of components and their interfaces. Although the supplier can resolve this uncertainty at least partially by gathering extra information, the buyer cannot resolve it, because interfaces are proprietary to the supplier.

We contend that the effect of modularity is even more negative when the vendor has resources in place for integrating customer knowledge in its channel. Vendors with well-developed customer knowledge mobilization resources are able to reduce the uncertainty created by the lack of modularity better than the customer, whereas vendors with underdeveloped customer knowledge mobilization resources might incur similar bottlenecks as the customer. This may happen in several ways. First, compared with vendors with less developed resources, well-resourced vendors may be better able to scan the supply-side technological landscape to identify not only the best-of-class components but also a granularity of component attributes that fits the requirements of a heterogeneous customer base. Second, compared with vendors with less developed resources, well-resourced vendors may be better able to leverage their tight supplier-side couplings not only to encourage the development of appropriate components but also to ensure the availability of these components within a reasonable time frame. Thus,

> H_5: The relationship between modularity and vendor customization control is more negative for vendors with well-developed customer knowledge mobilization resources than for vendors with underdeveloped customer knowledge mobilization resources.

Interaction with technological unpredictability. H_2 proposed that vendor customization control would increase with technological unpredictability because higher technological unpredictability makes it difficult for the buyer to match its preferences accurately to the technical specifications of the product. Buyers facing these circumstances will increasingly rely on vendors for customizing products to their needs. For several reasons, we contend that this effect will be even more pronounced if the vendor has well-developed customer knowledge mobilization resources. First, research-and-development personnel could have a better ability to scan the developments in the component/attribute market and be able to communicate with the marketing personnel to derive feasible solutions. Second, specialized tacit skills embodied in the vendor's personnel and supplier base could be brought forth using cross-functional teams to resolve technical difficulties. Third, the vendor's built-in knowledge systems could generate an institutional memory of how the firm resolved similar problems in the past (Winter 1987). Vendors possessing high levels of these resources will be able not only to design more appropriate solutions but also to coordinate these developments better. Thus,

> H_6: The relationship between technological unpredictability and vendor customization control is more positive for vendors with well-developed customer knowledge mobilization resources than for vendors with underdeveloped customer knowledge mobilization resources.

Interaction with customer knowledge. H_3 proposed that higher buyer knowledge would lead to less vendor customization control because knowledgeable buyers have a more accurate assessment of their needs, are better able to translate their needs into appropriate product attributes, and do so with less effort than novice buyers. When the vendor has low customer knowledge mobilization resources, a knowledgeable customer will have a decisive preference for controlling the composition of the customized product. However, if the vendor possesses high levels of customer knowledge mobilization resources, the benefits from not maintaining customization control are lower for a knowledgeable buyer than for a novice buyer because a well-resourced vendor has systems and teams in place to enable translation of customer needs better than a poorly resourced vendor. Therefore, when dealing with such vendors, a knowledgeable buyer has less need to control all customization decisions to obtain a customized product that meets its needs (John, Weiss, and Dutta 1999). Thus,

> H_7: The relationship between customer knowledge and a vendor's customization control is less negative for vendors with well-developed customer knowledge mobilization resources than for vendors with underdeveloped customer knowledge mobilization resources.

Normative Implications

Note that though our conceptual model is based on the normative rationale embodied in the Coase theorem and the efficiency criterion, H_1–H_7 test only the descriptive effects. Specifically, these hypotheses outline the conditions under which contracting parties will choose a particular level of vendor control over customization. To the extent that the parties choose a level of vendor control, we need to ascertain the normative effects, that is, whether these decisions lead to actual gains (or losses).

To test for these normative effects, we proceed as follows: The efficiency criterion essentially suggests that contracting parties compare alternative modes of organization and select one that is preferred (i.e., one that enhances the gains) by all parties in the vertical exchange (e.g., buyer and seller). If parties follow this operating principle, the observed level of customization control should reflect the goal of enhancing the outcomes for the contracting parties, given a set of antecedent conditions. We explore these ramifications for three key outcome measures: (1) the closeness of the delivered product to the customer's needs, (2) the vendor's delivery performance, and (3) the vendor's operating profit from this specific customer relationship. The first two measures capture the key purported benefits to the customer from such customization efforts. Note that these two measures capture only the benefits and do not reflect the costs of customization to the customer; thus, the normative test on these variables assumes that the marginal costs of customization control are not affected by our antecedent variables.[3] The third measure captures the benefits to the vendor from offering customized products net of its costs; in effect, by tracking the surplus generated, this measure captures both the effectiveness and the cost efficiency of the choice for the vendor. We regress each of these performance measures on the interaction between customization control and our antecedent variables. To account for the endogeneity of customization control (the choice variable), we use the selection-correction estimation technique, as Garen (1984, 1988) suggests.

Control Variables

Various other factors may also influence customization control. We include the most prominent ones as control variables in our statistical tests. First, vendors with a long relationship history with a customer might have a better understanding of customer needs, and thus customers might be more willing to concede the control to the vendor. Second, buyers who procure a particular family of products from more than one vendor might be more willing to control the customization of those products because permitting individual vendors to customize could lead to mutually inconsistent product systems. Third, in relationships with high dollar value of purchase by the buyer, the vendor might be more willing to invest idiosyncratic assets in understanding customer needs; consequently, the vendor might have higher control over customization. Finally, we include the relative size of the vendor in relation to the customer and industry dummies, without any specific a priori expectations, to control for other firm-level and industry-level effects.

[3]We thank the two reviewers for their insights on this issue.

METHOD

To test our hypotheses, we study four complex product industries in which customized products are frequently offered: Industrial machinery and equipment (Standard Industrial Classification [SIC] 35), electrical and electronic equipment (SIC 36), transportation equipment (SIC 37), and instruments and related products (SIC 38). We conducted a pilot study and developed a questionnaire, collected survey data, validated our measurements, and then estimated a model to test our research hypotheses. We discuss each in turn.

Research Context

To verify that our theoretical framework was material in our research context, we conducted a series of detailed field interviews with sales managers in firms from each of the four industry sectors. Each firm sold custom-designed systems to customers. Each manager was directly involved in the customization decision and processes with respect to a particular customer of his or her firm. The interviews revealed several relevant issues. First, managers indicated that offering customized products was indeed a key feature of their product offerings. Second, we observed substantial variation in which party has control over the customization decision. For example, the sales manager of a firm that supplies engineered-to-order, drive-train systems to automotive original equipment manufacturers (OEMs) suggested that the OEM customers choose the precise specifications of the system and contract with the vendor firm for their supply. In contrast, the sales manager of a firm that supplies electronic control and power distribution systems to aerospace OEMs indicated that frequently, the vendor is called on either to work proactively with the customer to develop the technical specifications or to design the product that fulfills the customer's particular functional criteria/specifications. This provides anecdotal evidence that variation along the construct of customization control is indeed operative in these contexts. Third, the vendor's systems are composed of various components, subassemblies that are based on a vast range of technologies and are sold to industrial customers that vary in their level of expertise, skills, and size. This provides us with confidence that we will observe variation on the key independent variables in our model. Finally, each of the two-digit SIC sectors consists of many different four-digit SIC industries, which assures us that there is variation across the types of systems marketed by the vendors.

Pilot Study and Questionnaire Development

On the basis of these interviews, academic literature, and the business press, we developed a draft of the survey instrument. Several of our measures are grounded in existing theoretical literature. We adapted the technological unpredictability measure from the work of Heide and John (1990). We adapted our buyer know-how measure from the work of Stremersch and colleagues (2003). We developed the other three measures through a domain sampling approach. The items that reflect customization control and the vendors' customer knowledge mobilization resources are new measures for new constructs, for which we developed the aforementioned theoretical domain. Modularity is a well-defined construct in the technology literature, though it is only rarely measured. We developed our measure mainly on the basis of prior work by John, Weiss, and Dutta (1999) and Sanchez (1999). We then administered the survey instrument to sales managers in 21 firms to verify its wording, response formats, and clarity of instructions. On the basis of their feedback, we made appropriate changes to the survey instrument.

Data Collection Procedure and Data Quality

Unit of analysis. Our unit of analysis is a purchasing agreement between a vendor of engineered products belonging to any one of the four industries and a specific business customer. The customer needed to be the end user of the procured product/system; thus, the customer could not be a reseller and/or distributor. We also focused on relationships in which the product was not an off-the-shelf, standardized product but required some level of customization before it would be used by the customer. Finally, to avoid any confound regarding customer expertise, we required the vendor to deal directly with the customer and not a third-party agent (e.g., project consultants, system integrators) of the customer. This specific relationship was the focus of our subsequent data collection effort.

Contacting key informants. We purchased mailing and information lists of sales managers from two information vendors and merged them to generate a sampling frame of approximately 1900 sales managers working in firms with minimum annual sales of $100 million. We then used the key informant methodology (Campbell 1955) to contact and qualify these individuals. Multiple telephone calls using a snowball technique were required to qualify an informant at each firm. As a token of appreciation for participating in our study, we offered each key informant a customized report that summarized the relationship profiles in our sample and a benchmark report that compared the respective company's profile with the patterns uncovered in our data. Our qualification process yielded 926 valid informants who were willing to participate; this required us to make approximately five telephone calls per qualified informant. We mailed them the survey instruments along with a stamped, self-addressed envelope. Of the remaining 974 potential managers, 201 were inappropriate for the study, 138 declined to participate, and 635 could not be contacted despite repeated efforts. Using reminder cards and follow-up telephone calls, we received 309 completed questionnaires. We eliminated 5 of these responses because of excessive missing data, which gave us a final sample of 304 responses, for a response rate of 33%. This compares favorably with previous studies that used a similar qualifying technique and were based on similar settings (Stump and Heide 1996).

Assessing key informant quality and nonresponse bias. To assess the quality of our key informants, we used two self-reported items to measure informant involvement and knowledge: "How involved are you personally in your business unit's dealings with this customer?" and "How knowledgeable are you about your business unit's dealings with this customer?" Their responses on a seven-point Likert scale (1 = "very low," 7 = "very high") averaged 6.60 (SD = .53) and 6.67 (SD = .41) for involvement and knowledge, respectively. None of the informants rated themselves below 5 on either of the two scales. This provides us with some confidence in the informants' ability to shed light on the details of the relationship. To assess nonresponse bias (Armstrong and Overton 1977), we observed that slightly more than half of our responses were returned within three weeks of mailing the initial survey, and the remaining responses were returned after three weeks. We classified the former set as early respondents and the latter set as late respondents. Using a multivariate analysis of variance, we found no statistically significant difference between these two groups on key demographic characteristics, suggesting that nonresponse bias was not an issue in our data.

Measurement Validation

We validated the measurement properties of our multi-item constructs using confirmatory factor analysis. This model included 29 indicators for five constructs (for all items, see Appendix A): customization control (9 items), modularity (5 items), technological unpredictability (4 items), customer knowledge (5 items), and vendor customer knowledge mobilization resources (6 items). The fit of the model was acceptable: $\chi^2 = 1147.57$, d.f. = 345, $p < .01$; comparative fit index (CFI) = .91; incremental fit index (IFI) = .91; and root mean square error of approximation = .08.

Anderson and Gerbing (1988) also advise to check measurement scales for unidimensionality, reliability, and convergent and discriminant validity. We discuss each in turn. The constructs in the model all showed unidimensionality. First, factor analyses on all respective scale items, taken one scale at a time, showed that only one factor was extracted (using the typical cut-off of an eigenvalue of 1.0). This shows that the respective scale items for each construct shared only one single factor. In addition, these single-factor measurement models all had an acceptable fit. Second, we assessed the magnitude of the residuals and modification indexes of the five-factor model. A vast majority was below 2, which is low given the size of the model, and we found no substantial departures from unidimensionality. Third, the previously reported fit of the measurement model is satisfactory, which would not be the case if unidimensionality were lacking. The conclusion is that the measures showed satisfactory unidimensionality. The composite reliability of all our scales is acceptable (Nunnally 1978), and so is the extracted variance, which is a more conservative measure than the composite reliability (Bagozzi and Yi 1988).

Convergent validity can be assessed from the path coefficients from the latent constructs to their corresponding manifest indicators. All loadings on the corresponding construct were significant at $p < .01$, and all t-values were larger than 10. All parameter estimates were at least ten times as large as the standard errors (Anderson and Gerbing 1988). Thus, the measures showed satisfactory convergent validity.

They also showed high discriminant validity; the latent correlation between any two constructs plus or minus twice the standard error did not include 1.0. Furthermore, the procedure that Bagozzi and Yi (1988) suggest showed high discriminant validity for all our measures. This procedure entails estimating two factor models for each pair of constructs, once with and once without constraining the correlation between the two constructs to unity. If a chi-square difference test, which compares the chi-square statistic of the constrained model with the chi-square statistic of the unconstrained model, is significant (which was the case for all pairs of constructs), the unconstrained model fits significantly better than the constrained model, which is evidence for discriminant validity. All possible pairs of constructs also passed Fornell and Larcker's (1981) test for discriminant validity. This test examines the amount of variance extracted by each construct (taking into account measurement error) relative to the squared correlation between pairs of constructs. Thus, we can conclude that the measures show high convergent and discriminant validity.

Appendix A provides the items of the different constructs and their measurement properties. Regarding the latter, we display their reliabilities both run as a single-construct measurement model and incorporated in the full measurement model. Appendix B also shows the pairwise correlations between all constructs.

Model Estimation and Results

We estimated our conceptual model for the extent of vendor control over customization decisions and its normative implications using the following four equations:

$$(1)\quad \text{CUSTCONTROL} = \beta_0 + \beta_1 \times \text{MOD} + \beta_2 \times \text{TECHUNPR} + \beta_3 \times \text{CUSTKNOW} + \beta_4 \times \text{MOBRES} + \beta_5 \times \text{MOD} \times \text{MOBRES} + \beta_6 \times \text{TECHUNPR} \times \text{MOBRES} + \beta_7 \times \text{CUSTKNOW} \times \text{MOBRES} + \beta_8 \times \text{NUMSUP} + \beta_9 \times \text{LOGYEARS} + \beta_{10} \times \text{LOGSALES} + \beta_{11} \times \text{LOGRELSIZE} + \Sigma\beta_i \times \text{INDUSTRYDUMMY} + \varepsilon.$$

$$(2)\quad \text{CLOSENEEDS} = \delta_0 + \delta_1 \times \text{MOD} \times \text{CUSTCONTROL} + \delta_2 \times \text{TECHUNPR} \times \text{CUSTCONTROL} + \delta_3 \times \text{CUSTKNOW} \times \text{CUSTCONTROL} + \delta_4 \times \text{MOBRES} \times \text{CUSTCONTROL} + \delta_5 \times \text{MOD} \times \text{MOBRES} \times \text{CUSTCONTROL} + \delta_6 \times \text{TECHUNPR} \times \text{MOBRES} \times \text{CUSTCONTROL} + \delta_7 \times \text{CUSTKNOW} \times \text{MOBRES} \times \text{CUSTCONTROL} + \delta_8 \times \text{NUMSUP} + \delta_9 \times \text{LOGYEARS} + \delta_{10} \times \text{LOGSALES} + \delta_{11} \times \text{LOGRELSIZE} + \Sigma\delta_i \times \text{All lower-order terms} + \phi.$$

$$(3)\quad \text{DELPERF} = \gamma_0 + \gamma_1 \times \text{MOD} \times \text{CUSTCONTROL} + \gamma_2 \times \text{TECHUNPR} \times \text{CUSTCONTROL} + \gamma_3 \times \text{CUSTKNOW} \times \text{CUSTCONTROL} + \gamma_4 \times \text{MOBRES} \times \text{CUSTCONTROL} + \gamma_5 \times \text{MOD} \times \text{MOBRES} \times \text{CUSTCONTROL} + \gamma_6 \times \text{TECHUNPR} \times \text{MOBRES} \times \text{CUSTCONTROL} + \gamma_7 \times \text{CUSTKNOW} \times \text{MOBRES} \times \text{CUSTCONTROL} + \gamma_8 \times \text{NUMSUP} + \gamma_9 \times \text{LOGYEARS} + \gamma_{10} \times \text{LOGSALES} + \gamma_{11} \times \text{LOGRELSIZE} + \Sigma\gamma_i \times \text{All lower-order terms} + \psi.$$

$$(4)\quad \text{OPERPROF} = \lambda_0 + \lambda_1 \times \text{MOD} \times \text{CUSTCONTROL} + \lambda_2 \times \text{TECHUNPR} \times \text{CUSTCONTROL} + \lambda_3 \times \text{CUSTKNOW} \times \text{CUSTCONTROL} + \lambda_4 \times \text{MOBRES} \times \text{CUSTCONTROL} + \lambda_5 \times \text{MOD} \times \text{MOBRES} \times \text{CUSTCONTROL} + \lambda_6 \times \text{TECHUNPR} \times \text{MOBRES} \times \text{CUSTCONTROL} + \lambda_7 \times \text{CUSTKNOW} \times \text{MOBRES} \times \text{CUSTCONTROL} + \lambda_8 \times \text{NUMSUP} + \lambda_9 \times \text{LOGYEARS} + \lambda_{10} \times \text{LOGSALES} + \lambda_{11} \times \text{LOGRELSIZE} + \Sigma\lambda_i \times \text{All lower-order terms} + \zeta.$$

In Equation 1, we summarize the factors (i.e., hypothesized and control) that affect the level of control the vendor takes in the customization decision pertaining to a specific customer relationship. Equations 2–4 pertain to the three outcome measures that assess the normative implications of the customization decision for the buyer and the vendor.[4] The right-hand-side variables in Equations 2–4 are interaction terms constructed from CUSTCONTROL and each of our seven hypothesized effects. The "all lower-order terms" in Equations 2–4 refer to all lower-order terms that are included, as per convention, to demonstrate support for hypothesized higher-order effects after we control for lower-order effects. To focus attention on the hypothesized effects, we do not discuss these other effects. We estimated Equations 2–4 separately.

Before we proceed to a discussion of our results, we take a brief methodological detour. Our theoretical framework, which is based on the efficiency criterion, contends that parties strategically choose the level of vendor control over customization with the goal of enhancing joint performance. This endogeneity of CUSTCONTROL leads to the classic self-selection problem (Heckman 1979) in the outcome of Equations 2–4. Statistically, the problem reduces to the issue that the error terms in the CUSTCONTROL and

[4]Although our model contends that companies choose customization control to derive optimal outcomes, observed choices need not be optimal because of uncertainty in both the choice and the performance equations. For example, certain firm-specific considerations, measurement difficulties, or even random noise may make contracting parties mistakenly choose the wrong level of customization control. In our in-depth interviews that preceded the survey, several respondents hinted that possible inefficiencies remained in the extent to which they took customization control. However, these mistakes enable us to address identification considerations that are essential for estimating Equations 2–4. We thank a reviewer for this suggestion.

the three outcome equations are not independent and that the expectations of ϕ, ψ, and ζ are not zero (Franses 2005).

A two-step procedure that considers self-selection a problem of omitted variables has been shown to be an appropriate estimation technique (Heckman 1979; Maddala 1983). However the Heckman–Lee estimator corrects for selection in a binary/multinomial choice scenario, whereas our selection variable, CUSTCONTROL, is continuous. Thus, to generate consistent estimates for a continuous selection variable, we use a variation of the two-stage Heckman–Lee estimator, as Garen (1984, 1988) suggests. Another salient feature of the Garen estimator is that it permits us to model unobserved heterogeneity associated with different levels of the selection variable, CUSTCONTROL. Specifically, using the logic that unobserved factors may affect outcome measures differently at different levels of the choice variable, we allow the residuals ϕ, ψ, and ζ to vary with the level of CUSTCONTROL.

Accordingly, we used the following steps for our estimation purpose. First, we estimated our CUSTCONTROL equation. To account for heteroskedasticity, we used the generalized least squares (GLS) technique (White 1980). Second, we computed the residuals from Equation 1 ($\hat{\eta}$) and the interaction term $\hat{\eta} \times$ CUSTCONTROL. Third, we added these two terms to Equations 2–4, which we in turn estimated using GLS. The $\hat{\eta}$ term corrects for the selection bias, and the $\hat{\eta} \times$ CUSTCONTROL term accounts for the unobserved heterogeneity over the range of our continuous selection variable, CUSTCONTROL. Finally, we mean-centered all the variables to limit multicollinearity and improve the interpretability of the main effects (Aiken and West 1991).

Table 1 provides the GLS estimates for the CUSTCONTROL equation. The adjusted R-square is .38, suggesting that the variables account for a substantial portion of the variance. Consistent with H_1, we find that as modularity increases, the level of vendor control over customization decreases ($\hat{\beta}_1 = -.18$, $p < .05$). This finding is in line with our feedback from in-depth interviews with managers. For example, a supplier of automatic tire inflation and stabilizing systems to the automotive industry (Firm 1) suggested that when the subassemblies could be mixed and matched, the customer was the arbiter of the configuration; however, when customers needed some specific technical configuration and mixing and matching was not readily possible, extensive adaptation was required on the part of both the

Table 1

RESEARCH FINDINGS: CUSTOMIZATION CONTROL

Independent Variables	*Hypothesized Relationship*	*CUSTCONTROL (GLS)*	*CUSTCONTROL (PROBIT)*
Constant		–.40	.001
		(.735)	(.008)
Effects of Theoretical Interest			
MOD	–	–.175**	–.437**
		(.083)	(.178)
TECHUNPR	+	.309***	.815***
		(.065)	(.192)
CUSTKNOW	–	–.263***	–.610***
		(.063)	(.189)
MOBRES	+	.043	–.290
		(.047)	(.227)
MOD × MOBRES	–	–.124**	–.455**
		(.063)	(.169)
TECHUNPR × MOBRES	+	.014	–.119
		(.043)	(.195)
CUSTKNOW × MOBRES	+	.336***	1.027***
		(.084)	(.241)
Control Variables			
NUMSUP		–.190***	–.516***
		(.057)	(.167)
LOGYEARS		.152**	.384**
		(.064)	(.210)
LOGSALES		.019	.073
		(.041)	(.131)
LOGRELSIZE		.084***	.144*
		(.027)	(.084)
INDUSTRYDUMMY_1 (if SIC 36 = 1; other = 0)		–.054	–.537
		(.114)	(.397)
INDUSTRYDUMMY_2 (if SIC 37 = 1; other = 0)		.008	–.075
		(.141)	(.422)
INDUSTRYDUMMY_3 (if SIC 38 = 1; other = 0)		–.038	–.567
		(.154)	(.499)
Other Model Statistics			
R^2/Wald χ^2(d.f.)		.427	62.223 (14)***
Adjusted R^2/pseudo R^2		.381	.311
F statistic (14, 286)		13.731	

*$p < .10$ (two-sided tests).
**$p < .05$ (two-sided tests).
***$p < .01$ (two-sided tests).

customer and the vendor. Consequently, the vendor's involvement in the configuration dramatically increased.

Consistent with H_2, we find that as the technological unpredictability increases, the level of vendor control over customization increases ($\hat{\beta}_2$ = .31, p < .01). This finding also received strong face validity in our interviews. For example, a leading supplier of fluid-handling/aqueous systems (which are composed of a dizzying array of electronic and hydraulic sensors, purge controllers, filters, and so forth) to the food, dairy, and beverage industry (Firm 3) suggested that recent advances in relevant instrumentation and material science technologies had been rapid, and many customers (dairy cooperatives, beverage manufacturers), eager to understand how these developments might make their processes more efficient, frequently asked the vendor to develop systems that incorporated these technologies for their idiosyncratic needs.

In support of H_3, we find that as the customer knowledge in the product category increases, the level of vendor control over customization decreases ($\hat{\beta}_3$ = –.26, p < .01). This finding also received face validity in our interviews. For example, the sales manager in Firm 1 suggested that many of the firm's customers are knowledgeable and provide specific designs for particular automotive models. The vendor's task then is to physically engineer the system for the customers.

In support of H_5, we find that when vendors have high levels of customer knowledge mobilization resources, they have lower levels of control over customization when the modularity of the system is high ($\hat{\beta}_5$ = –.12, p < .05). In support of H_7, we find that when vendors with high levels of customer knowledge mobilization resources deal with expert customers, the level of vendor control over customization increases ($\hat{\beta}_7$ = .34, p < .01). Together, these results provide support for our theoretical framework.

We did not find support for H_4 or H_6 in our data. The reason for not finding support for the main effect between vendors' customer knowledge mobilization resources and customization control (H_4) may be the highly contingent nature of this relationship, as supported by significant interaction effects with modularity and customer knowledge. The reason for not finding support for the interaction effect between technological unpredictability and vendors' customer knowledge mobilization resources (H_6) may be somewhat less straightforward. A plausible explanation is that a vendor's customer knowledge mobilization resources may also make it easier for the customer to tap into the vendor's technological knowledge. If this is the case, the prime motivation for the customer under high-technological-unpredictability conditions (lack of technological foresight) to cede customization control disappears.

Turning to the control variables, we find that vendor control over customization decreases as the number of vendors from which the buyer procures the focal product increases ($\hat{\beta}_8$ = –.19, p < .01) and increases as the length of the relationship ($\hat{\beta}_9$ = .15, p < .05) and the relative size of the vendor with respect to the customer ($\hat{\beta}_{10}$ = .08, p < .01) increases. Neither dollar volume of sales to the customer nor industry-specific dummy variables have an impact in our sample.

To verify the robustness of our results, we estimated the model using an alternative estimation technique. Specifically, we dichotomized the CUSTCONTROL variable such that all values lower than 4 were categorized into "0" and all values equal to or higher than 4 were categorized into "1." We then estimated this binary choice equation using probit analysis. The last column in Table 1 provides the estimates for the probit analysis. The results are consistent with those we obtained using GLS, showing that our findings are robust to alternative specifications. We now turn to the results for our three outcome measures.[5]

Closeness to customer needs (CLOSENEEDS). Table 2 provides these results. Note that the coefficient of $\hat{\eta}$ is significant, indicating the existence of the selection bias and suggesting that, on average, contracting parties select the level of CUSTCONTROL to improve the fit between the customized product and buyer needs. The substantive interpretation of the positive coefficient is that the customer had ceded control to the vendor beyond the expected levels and that such customers were able to obtain a better fit between the product and their needs (Garen 1984). The coefficient of the interaction term $\hat{\eta}$ × CUSTCONTROL is also significant and positive, indicating that the effect of the selection bias is even more pronounced for higher levels of CUSTCONTROL.

Turning to our core results, we find that the closeness of the delivered product to customer needs is lower when the vendor has a high level of customization control under high modularity ($\hat{\delta}_1$ = –.48, p < .01), higher when the vendor has a high level of customization control under high levels of technological unpredictability ($\hat{\delta}_2$ = .46, p < .01), lower when experienced customers cede the control of the customization decision to the vendor ($\hat{\delta}_3$ = –.27, p < .01), lower when the vendor with a high level of customer knowledge mobilization resources has customization control when the within-product modularity is high ($\hat{\delta}_5$ = –.10, p < .05), and higher when the vendor with a high level of customer knowledge mobilization resources has control over the customization for experienced customers ($\hat{\delta}_7$ = .16, p < .01). The remaining hypothesized effects were not supported.

Delivery performance (DELPERF). The coefficient of $\hat{\eta}$ is significant, indicating the existence of the selection bias. The positive coefficient has the same interpretation as that which we made previously. The nonsignificant coefficient on $\hat{\eta}$ × CUSTCONTROL suggests that there was no unobserved heterogeneity over the range of CUSTCONTROL. Turning to the core results, we find that the delivery performance is lower when a vendor has a high level of customization control under high modularity ($\hat{\gamma}_1$ = –.27, p < .01), higher when a vendor has a high level of customization control under high levels of technological unpredictability ($\hat{\gamma}_2$ = .21, p < .05), and higher when a vendor with high levels of customer knowledge mobilization resources has control over the customization for experienced customers ($\hat{\gamma}_7$ = .14, p < .10). The remaining hypothesized effects were not supported.

Operating profits of the vendor (OPERPROF). Note that the coefficient of $\hat{\eta}$ is only marginally significant, indicating that there are substantial differences among companies regarding the extent to which their customization control is driven by profit considerations. The coefficient of $\hat{\eta}$ ×

[5]We also estimated each of the three outcome equations using the discrete choice, switching regression approach (Maddala 1983). The results were consistent with the findings for the continuous version of the selection variable, CUSTCONTROL.

Table 2

RESEARCH FINDINGS: PERFORMANCE EQUATION

Independent Variables	*CLOSENEEDS*	*DELPERF*	*OPERPROF*
Constant	3.84***	4.52***	4.10***
	(.96)	(.37)	(.57)
Effects of Theoretical Interest			
MOD × CUSTCONTROL	–.48***	–.27***	–.35***
	(.09)	(.10)	(.11)
TECHUNPR × CUSTCONTROL	.46***	.21**	–.28***
	(.07)	(.11)	(.10)
CUSTKNOW × CUSTCONTROL	–.27***	.03	–.07
	(.05)	(.06)	(.07)
MOBRES × CUSTCONTROL	–.08	–.05	.49***
	(.07)	(.09)	(.11)
MOD × CUSTCONTROL × MOBRES	–.14**	–.03	–.16*
	(.06)	(.07)	(.09)
TECHUNPR × CUSTCONTROL × MOBRES	.05	.01	.51***
	(.09)	(.09)	(.14)
CUSTKNOW × CUSTCONTROL × MOBRES	.16***	.14*	–.13
	(.07)	(.09)	(.11)
All Lower-Order Terms			
CUSTCONTROL	–.01	–.82***	.25
	(.19)	(.27)	(.28)
MOD	.08	–.14	.15
	(.06)	(.09)	(.11)
TECHUNPR	–.19**	.16	–.08
	(.08)	(.10)	(.12)
CUSTKNOW	.08	–.26**	–.03
	(.07)	(.10)	(.11)
MOBRES	–.13*	.07	.02
	(.07)	(.08)	(.10)
MOBRES × MOD	–.08	–.07	.17**
	(.06)	(.06)	(.08)
MOBRES × TECHUNPR	.32***	.26**	.01
	(.06)	(.11)	(.09)
MOBRES × CUSTKNOW	.01	.52***	.27*
	(.09)	(.16)	(.14)
Control Variables			
NUMSUP	.00	.00	–.01*
	(.01)	(.01)	(.01)
LOGYEARS	–.13*	.09	.43***
	(.07)	(.10)	(.12)
LOGSALES	.03	–.03	–.09
	(.06)	(.06)	(.09)
LOGRELSIZE	.03	.08*	.07
	(.04)	(.05)	(.06)
Other Model Statistics			
$\hat{\eta}$	.28**	.56***	.17*
	(.14)	(.16)	(.11)
$\hat{\eta}$ × CUSTCONTROL	.37***	.05	.04
	(.09)	(.11)	(.12)
R^2; adjusted R^2	.47; .37	.26; .19	.31; .23
F statistic (21, 269)	20.89	8.67	9.62

*$p < .10$ (two-sided tests).
**$p < .05$ (two-sided tests).
***$p < .01$ (two-sided tests).

CUSTCONTROL is not significant. Turning to our results, we find that a vendor's operating profits are lower when a vendor under high modularity has a high level of customization control ($\hat{\lambda}_1 = -.35$, $p < .01$), higher when a vendor with high customer knowledge mobilization resources has a high level of customization control ($\hat{\lambda}_4 = .49$, $p < .01$), lower when a vendor with high levels of customer knowledge mobilization resources has a high level of customization control under high modularity ($\hat{\lambda}_5 = -.16$, $p < .10$), and higher when a vendor with high levels of customer knowledge mobilization resources has a high level of customization control under high technological unpredictability ($\hat{\lambda}_6 = .14$, $p < .10$). Contrary to our reasoning, we find that a vendor's operating profits are lower when it has customization control under high technological unpredictability ($\hat{\lambda}_2 = -.28$, $p < .01$). The remaining hypothesized effects were not supported.

To get an intuitive feel for the interaction effects, we generated Figures 1 and 2, which show the three-way interaction effect for high (two standard deviations above the mean) and low (two standard deviations below the mean) values of customization control on the closeness to customer needs. The key independent variables are customer knowledge and vendor customer knowledge mobilization resources in Figure 1 and product modularity and vendor customer knowledge mobilization resources in Figure 2. To facilitate comparison, we kept the "plot ranges" identical for each set of figures. Several notable observations can be gleaned from these plots. First, in both figures, the surfaces are steeper for high values of customization control than for low values. Second, in the high-customization-control case, the surfaces rise (dip) sharply for high values of each of the two independent variables. Specifically, when customer expertise is high, the closeness of the product to customer needs is much higher when vendors with high customer knowledge mobilization resources have control over customization than when they do not have such control. Similarly, when product modularity is high, the closeness of the product to customer needs is much lower when vendors with high customer knowledge mobilization resources have control over customization than when they do not have such control. The plots for three-way interaction effects on other outcome measures show a similar pattern; however, space considerations prevent us from discussing them in detail.

DISCUSSION

The organization of vertical trading relationships has been an important field of research in marketing. Williamson (1999) challenged researchers to incorporate explicitly both strategic and efficiency considerations by asking, How should a firm with preexisting resources and capabilities organize transaction X? In this article, we develop a conceptual model that shows how unique, firm-specific resources (in our case, vendor customer knowledge mobilization resources) modulate the effect of technology and customer-side considerations on vendors that market complex products to business customers. Next, we discuss the substantive implications of our research for practice and then turn to a discussion of the limitations of the study and avenues for further research.

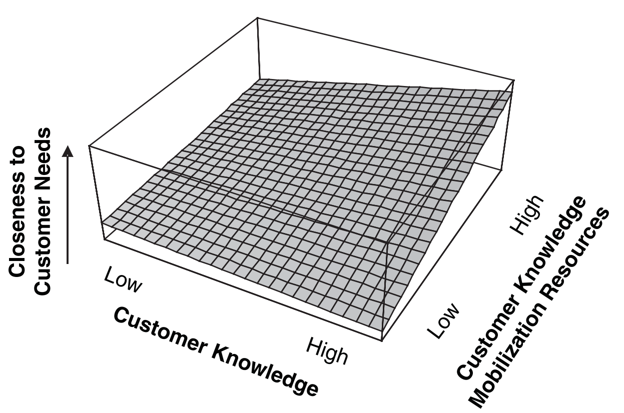
Implications for Practice

Designing appropriate marketing systems is the key to the overall effectiveness of marketing practices. Our study focuses on one such important decision faced by vendors that market complex products to business customers: How much control should the vendor have over customization

Figure 1

THREE-WAY EFFECT OF CUSTOMER KNOWLEDGE, VENDOR KNOWLEDGE, AND CUSTOMIZATION CONTROL ON CLOSENESS TO CUSTOMER NEEDS

A: High Customization Control



B: Low Customization Control

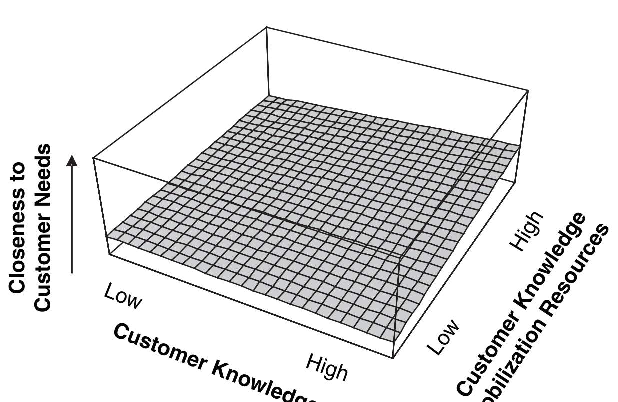
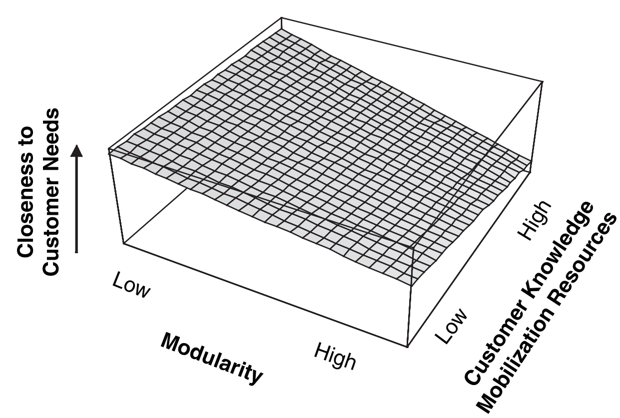


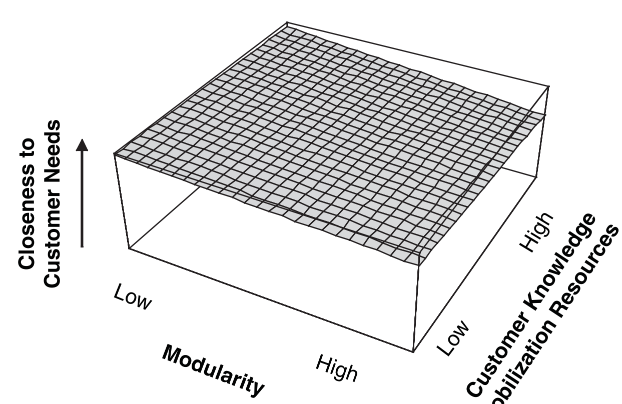
Figure 2

THREE-WAY EFFECT OF MODULARITY, VENDOR KNOWLEDGE, AND CUSTOMIZATION CONTROL ON CLOSENESS TO CUSTOMER NEEDS

A: High Customization Control



B: Low Customization Control



decisions in a particular customer relationship? Our findings offer specific guidance to companies.

First, vendors should take more customization control with increasing technological unpredictability and decreasing modularity and customer knowledge. Firms operating in highly unpredictable technological environments, in which different, incompatible standards exist and customers are relatively inexperienced, should aim for a higher customization control. Consistent with our conceptualization that these decisions by vendors are strategic, we also find that the same technology and knowledge factors affect vendors' profits and their ability to offer solutions that better meet their customers' needs.

Second, we find that the extent to which vendors should take customization control also depends on their own resources. Specifically, we identified the vendor's customer knowledge mobilization resources as being critical. The vendor's customer knowledge mobilization resources can affect the optimal customization control for the vendor in two ways. First, when dealing with knowledgeable customers, vendors with high customer knowledge mobilization resources can actually provide value by having more control over the customization decision than vendors with low customer knowledge mobilization resources because they are better able to assess and deliver solutions that meet the needs of the customer. The logic of this counterintuitive finding is that when highly resourced vendors deal with highly competent customers, the "absorptive capacity" (John, Weiss, and Dutta 1999) of the exchange can be high for both parties, and this enhances the ease with which the vendor can design customized solutions. Second, when product modularity is low, highly resourced vendors can more effectively reduce uncertainty introduced by a lack of modularity through identifying best-of-class components that are a better match to particular customers' needs or use their supply-side couplings to develop appropriate components than vendors with low customer knowledge mobilization resources. Conversely, when product modularity is high, rather than concentrate on proactively involving themselves in product design for each customer, highly resourced vendors can focus on setting up back-office operations, such as identifying the most desired components, developing links with their component suppliers to secure the timely supply of appropriate components, and setting up a customer-side interface that permits customers to mix and match and choose their most desired product configurations.

Third, companies that take these recommendations to heart will find a better match with their customers' needs and increase their delivery performance. Furthermore, they will increase their overall performance.

Limitations and Further Research

Our results are context dependent; thus, we advise caution when attempting to generalize our insights in other contexts. Although we test our theory both descriptively and normatively and provide some anecdotal evidence on the causal processes underlying our theory, other limitations remain. For example, we do not have a direct measure of the motivation of our informants for choosing a particular level of control over the customization decision. Rather, we assume that their observed choice is their preferred mode of operation in that customer relationship. Although we have control variables for various general and industry-specific factors, it is possible that there are other mechanisms at work and, thus, alternative explanations. In addition, unobserved heterogeneity in these product markets remains a possibility even though we controlled for industry-specific fixed effects using dummy variables. Another limitation of our study is the performance measures we used for the normative analysis. These variables are subjective estimates, and they are obtained only from one side of the dyad. An analysis of the joint outcomes might reveal a different pattern. Furthermore, performance is a multidimensional construct; the impact of the customization decision on other measures could potentially be different from those we obtained in this study. In particular, it would be worthwhile to explore the impact on the direct costs of providing customized solutions. We hope that future studies will address these limitations.

Appendix A

OPERATIONALIZATION OF MULTI-ITEM CONSTRUCTS

Scale and Model Statistics	*Item Description*
CUSTCONTROL Customization control (number of items = 9) *Individual Model* CFI = .94; IFI = .94; reliability = .98 *Full Model* Composite reliability = .97 Extracted variance = .78	1. The set of features in the final product/service is decided entirely by this customer./The set of features in the final product/service is decided entirely by us. 2. This customer composes the product to its specific needs./We compose the product to the specific needs of the customer. 3. This customer is primarily responsible for composing the customized solution to its needs./We are primarily responsible for composing the customized solution to this customer's needs. 4. We enable this customer to design the product to its requirements without any specific assistance from us./We design the product to this customer's requirements (possibly after a significant interaction with the customer). 5. We offer a set of components that this customer mixes and matches to customize this product./We mix and match components into a customized product that matches the specific needs of this customer. 6. The design of the customized product is primarily done by this customer./The design of the customized product is primarily done by us. 7. This product can be customized without much assistance or advice from us./This product can be customized only after extensive interaction between us and this customer. 8. Detailed analysis in translating its needs into product specifications is primarily done by this customer./Detailed analysis in translating this customer's particular needs into product specifications is primarily done by us. 9. Our product is composed so that this customer can put it together./Our product is composed so that only we can put it together.

Appendix A
CONTINUED

Scale and Model Statistics	*Item Description*
MOD Modularity (number of items = 5) *Individual Model* CFI = .94; IFI = .94; reliability = .94 *Full Model* Composite reliability = .92 Extracted variance = .69	1. The composition of our product can be easily altered without triggering compatibility concerns. 2. The configuration of our product is based on standard interfaces. 3. The composition of our product is perfectly modular. 4. The composition of our product can be chosen without taking into account other aspects (e.g., components, design, standards) of the product. 5. Certain aspects of our product configuration can be easily replaced with similar configurations from another manufacturer without raising compatibility issues.
TECHUNPR Technological unpredictability (number of items = 4) *Individual Model* CFI = .99; IFI = .99; reliability = .98 *Full Model* Composite reliability = .95 Extracted variance = .83	1. The technological evolution in this product category is predictable. (R) 2. We are seldom surprised about the technological evolution in this product category. (R) 3. Technological advances in this product can be predicted beforehand. (R) 4. Foreseeing new technological advances in this product category is quite easy. (R)
CUSTKNOW Know-how of the customer (number of items = 5) *Individual Model* CFI = .95; IFI = .95; reliability = .93 *Full Model* Composite reliability = .91 Extracted variance = .68	Concerning the product we sell to this customer, I would consider this customer to be: 1. Very knowledgeable. 2. Very competent. 3. Highly expert. 4. Very well trained. 5. Very experienced.
MOBRES Vendor customer knowledge mobilization resources (number of items = 6) *Individual Model* CFI = .91; IFI = .91; reliability =.93 *Full Model* Composite reliability = .92 Extracted variance = .67	1. We have setup procedures to co-opt with our suppliers in designing the best solutions for our customer's needs. 2. We have companywide systems to involve the customer in understanding the technological capabilities of our company. 3. We have cross-functional teams to enable the translation of customer needs into product features. 4. We have set up a knowledge system to transfer our experience from one customer context to another. 5. We have instituted policies to permit adaptation of our product configuration to customer needs. 6. Our research team has the means to extend the boundaries of our technological capabilities to provide customer solutions.
CLOSENEEDS Closeness of delivered product to customer needs	The degree to which we met the needs of the customer in this relationship was "very low" (1) or "very high" (7).
DELPERF Delivery performance	Our delivery performance in this relationship was "very low" (1) or "very high" (7).
OPERPROF Operating profits for the vendor of this relationship	Our operating profits in this relationship were "very low" (1) or "very high" (7).
NUMSUP Number of suppliers of buyer	Including your firm, from how many suppliers do you think this customer sources its requirements for this product?
YEARS Length of relationship	How long has your business unit had a business relationship with this customer? (in years and months)
SALES Dollar value of purchase	During the last fiscal year, what was the total volume purchase of the identified item by this customer? (in dollars)
RELSIZE Relative size of contracting parties	With respect to your business unit's total sales volume last year, how large is your firm relative to this customer?

Notes: All scales are seven-point Likert scales (1= "totally disagree," 7 = "totally agree"), except for the first scale of customization control, which is a semantic differential scale. R = reverse-scale items.

Appendix B

CORRELATION MATRIX

Construct	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1. CUSTCONTROL	1.00																					
2. MOD	–.29	1.00																				
3. TECHUNPR	.35	–.29	1.00																			
4. CUSTKNOW	–.20	–.03	.05	1.00																		
5. MOBRES	.06	.12	.04	.05	1.00																	
6. NUMSUP	–.31	.16	–.05	.08	–.07	1.00																
7. LOGYEARS	.02	–.05	–.27	.09	–.08	–.05	1.00															
8. LOGSALES	.01	–.02	.00	.05	.05	–.11	.01	1.00														
9. LOGRELSIZE	.07	.07	–.07	–.11	–.06	–.02	–.20	.25	1.00													
10. CLOSENEEDS	–.06	–.02	–.14	.02	.08	–.02	–.10	.03	.05	1.00												
11. DELPERF	–.09	–.01	–.11	.01	.13	.05	–.02	–.02	–.22	.41	1.00											
12. OPERPROF	.20	–.11	–.04	.10	.08	–.09	.22	–.01	–.01	–.14	–.08	1.00										
13. MOD × MOBRES	–.23	–.04	–.19	.07	–.11	.04	.11	.06	.16	–.04	–.04	.10	1.00									
14. TECHUNPR × MOBRES	.22	–.23	.11	–.05	–.05	–.21	.04	.02	–.01	.08	.13	.04	–.09	1.00								
15. CUSTKNOW × MOBRES	.30	.08	–.05	.10	.12	–.08	.09	–.05	–.12	.09	.24	.17	–.14	.17	1.00							
16. MOD × CUSTCONTROL	.03	.21	.04	–.02	–.26	–.05	.17	.00	.03	–.33	–.20	–.03	.19	.14	–.04	1.00						
17. TECHUNPR × CUSTCONTROL	–.03	.04	.04	.06	.20	.01	.01	–.06	.04	.22	.24	–.12	.07	–.08	.07	–.30	1.00					
18. CUSTKNOW × CUSTCONTROL	–.09	–.02	.06	.04	.28	–.01	–.14	.07	–.04	–.25	.06	–.09	–.02	.10	.01	.03	.00	1.00				
19. MOBRES × CUSTCONTROL	.22	–.26	.20	.28	–.19	–.15	–.10	–.07	.07	–.17	–.21	.16	.01	.12	–.28	.31	–.02	–.08	1.00			
20. CUSTCONTROL × 13 (three-way)	.26	.15	.11	–.05	.02	.08	.13	–.11	–.14	–.16	–.04	–.08	–.19	.14	.07	.05	–.15	.06	–.06	1.00		
21. CUSTCONTROL × 14 (three-way)	.00	.13	–.07	.09	.12	–.06	–.12	.01	.08	.19	.02	.17	.11	–.22	.15	–.23	.16	–.07	–.12	–.06	1.00	
22. CUSTCONTROL × 15 (three-way)	–.10	–.06	.09	.00	–.28	–.05	–.22	.02	–.08	–.12	.04	–.13	.03	.17	–.20	.22	–.22	.43	.15	.04	–.01	1.00

Notes: Matrix represents pairwise correlations. All correlations greater than .11 are significant at the .05 level.

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