CUSTOMER INTERACTION AND INNOVATION IN HYBRID OFFERINGS: INVESTIGATING MODERATION AND MEDIATION EFFECTS FOR GOODS AND SERVICES INNOVATION

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Abstract

Hybrid offerings are conceptualized as a bundle of goods and services offerings provided by the same firm. While previous research has identified customer interaction as being positively related to innovation in goods and services industries, scarce research attention has been directed at the contributions achieved through customer interactions when hybrid offerings combine physical products and related services. This research therefore investigates the effects of customer interactions on both goods and service innovation in a hybrid offerings context, using a unique data set of 146 information technology and manufacturing firms. As a potential mediator, this research introduces vendors' customer knowledge mobilization resources and reveals different mediation effects for goods and service elements of hybrid offerings. Additionally, the roles of service customization and technical modularity are explored. While service customization has different direct effects on goods and services innovation, we find that for high-interaction customers, medium levels of technical modularity lead to most favorable innovation outcomes. The results suggest that providers of hybrid offerings should foster customer interaction because it drives innovation performance of the good and service component.

Keywords: Customer interaction, hybrid offerings, knowledge integration mechanisms, product innovation, service innovation

Harnessing customers' use-related knowledge, which stems from the actual use of products, enables producing firms to complement their own knowledge base (Chatterji and Fabrizio 2012, Von Hippel 1994). Exploiting this knowledge can contribute to innovation generation and enhance not only customer satisfaction but also firm performance (Chesbrough 2003, Stock 2011). Accordingly, innovation management literature advocates close customer collaboration in both business-to-business (Bonner and Walker 2004, Fang 2008, Noordhoff et al. 2011) and business-to-consumer (Sawhney, Verona, and Prandelli 2005, Vargo 2008) settings. Customer interaction has also been identified as a success factor for both innovation performance of services and innovation performance of tangible products (Carbonell, Rodríguez-Escudero, and Pujari 2009, Chen, Tsou, and Ching 2011, Homburg and Kuehnl 2014).

However, little research addresses customer interactions and their implications for hybrid offerings. Hybrid offerings combine physical products, or goods, and services into innovative solutions, such that they differ from both pure services (e.g., financial, health) and pure manufacturing offerings (e.g., machinery; Gebauer, Gustafsson, and Witell 2011, Shankar, Berry, and Dotzel 2009). For example, manufacturers in mechanical engineering sectors have evolved into sellers of hybrid value bundles and offer technical artifacts along with integrated forms of maintenance services (Sharma, Iyer, and Evanschitzky 2008).

Offering hybrid value bundles also affects how firms interact with customers. For example, compared to a goods-oriented logic of innovation, customer interaction is more intense for developing hybrid offerings as the rationale of having predominantly after sales customer contact is replaced by a service-oriented logic, where interaction is always a part of service development and innovation. In turn, compared to pure services, customer interaction in hybrid offerings involves more technical depth in conversations as innovation in services always has to be aligned with current technological developments. In addition, goods and services innovation processes mirror different approaches to innovate (Evanschitzky et al. 2012, Storey and Kahn 2010), implying that innovating hybrid offerings may be considered a mix of both. However, different approaches to innovate goods and services may compete for the same resources and outperform each other, a fact that prompts firms to optimize their relative emphasis on services and goods innovation.

Because extant research has focused on goods or services innovation within respective industries (e.g., Stock 2011, Homburg and Kuehnl 2014), not on the impact of customer interactions for goods and related service innovations simultaneously in a hybrid offerings context, an isolated view has emerged. Thus, we lack an understanding of the processes that turn customer interaction into innovation performance in either goods-related or service-related components of a hybrid offering. Yet a firm's ability to integrate external knowledge effectively and to offer hybrid offerings represents a competitive advantage (Ulaga and Reinartz 2011).

Due to the lack of an integrative view on innovations for goods and services, and based on theory related to organizational learning processes (Kale and Singh 2007) and knowledge integration mechanisms (De Luca and Atuahene-Gima 2007), this research seeks to clarify (1) whether paths that exist in isolation between customer interaction and goods innovation and customer interaction and services innovation remain stable for hybrid offerings and (2) if customer interaction affects one type of innovation, to the detriment of the other.

The reminder of the paper is organized as follows: First, discuss the role of customer interaction in hybrid offerings and consider service customization as a parallel direct influence firms have to manage in addition to customizing their products. Second, we investigate the role of a product's technical modularity, defined as a loose coupling between components and a tight coupling within components (Sanchez and Mahoney 1996), as a potential moderator between customer interaction and innovation performance as modularity is known to affect communication designs (Tiwana 2008). Finally, we discuss the implications of our results and avenues for further research. The results help reconcile prior findings on customer interaction and innovation performance and shed light on the complex interaction of knowledge sets for the development of hybrid offerings.

HYBRID OFFERINGS, CUSTOMER INTERACTION, AND INNOVATION PERFORMANCE

Context: Hybrid Offerings

In business-to-business (B2B) settings especially, goods offerings increasingly are complemented by added services, to form customer solutions or hybrid offerings in response to growing technological complexity, shortening product life cycles, and demanding customers (Antioco et al. 2008, Evanschitzky, Von Wangenheim, and Woisetschläger 2011). Shankar, Berry, and Dotzel (2007, p. 2) define hybrid offerings as "combinations of one or more goods and one or more services, creating more customer benefits than if the good and service were available separately." To be hybrid, an offering must come from one vendor that sells both good(s) and service(s), and the value of consuming the good and the service must be greater than consuming goods or services alone (Shankar et al. 2007). That is, the value of a hybrid offering consists of the value of its good component and the value of its service component. Hybrid offerings accordingly mirror the shift from goods- to a service-dominant logic (Vargo and Lusch 2008).

For example, producers of mobile phones have made sizable investments to create and maintain product ecosystems, comprising various services that complement the good, such as application worlds. Companies that failed to offer complementary services, such as Motorola, have faced considerable market losses (Chesbrough 2011), leading Lenovo, the parent company, to the decision to discontinue the Motorola brand (The Guardian 2016). Adding services to goods-centric offerings thus offers a promising means to stabilize revenue streams and increase revenues or profits (Fang, Palmatier, and Steeenkamp 2008). However, as Ulaga and Reinartz (2011, p. 12) maintain, hybrid offerings require specific capabilities such as a design-to-service-capability through which goods and service elements in hybrid offerings "interact synergistically for value creation rather than in a merely additive manner." Thus, understanding how customer interaction affects innovation outcomes for goods and service elements helps in finding synergies.

Customer Interaction, Knowledge Integration, and Innovation Performance

Customers represent a valuable source of knowledge (e.g., Bartl et al. 2012, Lau, Tang, and Yam 2010), which can become firms' market knowledge (Atuahene-Gima 1995; Kohli and Jaworski 1990). Customer knowledge further relates to both usage and technical components, which can expand the firm's technological knowledge. Both market and technological knowledge are indispensable antecedents of innovation, so interactions with customers during the innovation process appear promising in terms of better innovation outcomes and innovation performance (Fang 2008).

In B2B settings, interactions with customers span from high to low intensity. The interactions represent a set of behavioral activities designed to continuously (1) collect information and (2) process the collected information, whether by "meeting with customers to learn about their current and potential needs for new products, analyzing customer information, [or] using customers to test and evaluate new products or services" (Song, Tang, and Parry 2010, p. 559). Thus, when a firm interacts with a customer as part of the delivery process, customer knowledge tends to be conveyed through sales talks, contract negotiations, or technical discussions.

Organization theorists maintain that integrating customer knowledge requires "processes and structures that ensure the capture, analysis, interpretation, and integration of market and other types of knowledge among different functional units within the firm" (De Luca and Atuahene-Gima 2007, p. 95). Such processes and structures, often referred to as knowledge integration mechanisms, define innovation performance, along with market knowledge and cross-functional collaboration among the firm's functional units (Atuahene-Gima 2005; Day 1994). Some studies assume knowledge integration mechanisms moderate the relationship between market knowledge and innovation outcomes (Zahra, Ireland, and Hitt 2000), but more recent work proposes that market knowledge affects innovation performance indirectly, through the design of the knowledge integration mechanisms (De Luca and Atuahene-Gima 2007, Foss, Laursen, and Pedersen 2011, Ngo and O'Cass 2013).

Thus, possibly due to these opposing theoretical viewpoints, until today the pathways by which customer knowledge affects innovation outcomes are not entirely understood, especially in a hybrid offerings context where pathways for service-related knowledge may differ from pathways for goods-related knowledge (Höber and Schaarschmidt 2016).

CONCEPTUAL FRAMEWORK AND HYPOTHESES

We conceptualize customer interaction as the extent to which a supplier firm interacts with a customer firm during product customization.[1] The customization may be specified during sales talks, technical discussions, or the product delivery and implementation. We focus on customization in contrast to situations where standard goods are delivered with a single customer touchpoint because 1) customization requires customer interaction and 2) customization is conducted in a project-oriented manner with multiple touchpoints between vendor and customer. Such interactions, unlike the formal integration of customers into the R&D process (Franke, Von Hippel, and Schreier 2006), provides use-related knowledge in the form of suggestions, requirements, or complaints. These relatively loose customer–firm interactions thus prompt firms to tap absorbable, external, customer knowledge that can feed the firm's innovation program (Von Hippel 1978).

--- *Please insert Figure 1 about here* ---

In Figure 1, customer interaction is the basis for tapping customer knowledge, which can be exploited by the firm by integrating the knowledge into its R&D activities. The model relies on the premise that customer interaction directly and indirectly affects innovation performance, which we define as success relative to competitors both in terms of goods and services (Song, Dyer, and Thieme 2006). In the research model, customer interaction exerts a positive effect on both goods innovation performance and service innovation performance. Further, this link is

[1] Customer interaction is conceptually close but different from co-creation (e.g., Aarikka-Stenroos and Jaakkola 2012, Payne, Storbacka, and Frow 2008). While co-creation usually refers to a rather proactive part of the customer, customer interaction is driven by the vendor firm and the customer role is more of a passive nature.

mediated by vendor's customer knowledge mobilization resources. As we will delineate in the following sections, we predict the mediating effect to be stronger for goods than for service-related aspects of hybrid offerings innovation. In addition, the degree of service customization is predicted to positively affect service innovation but to negatively affect goods innovation. Finally, we propose a moderating effect of technical product modularity as modularity is (1) the most important design principle that affects communication in customer-vendor relationships (Tiwana 2008), and (2) is a necessity to offer customized technical products (Mikkola 2007).

Impacts of Customer Interaction on Goods and Service Innovation

Customer interactions provide firms with access to innovation-relevant knowledge, which is otherwise difficult and costly to obtain for the firm because of its tacit and distributed nature. These knowledge characteristics caused researchers to refer to "difficult-to-transfer-knowledge" as "sticky knowledge" (Von Hippel 1994). In their role as users, customers may share this knowledge when they expect gains through being an early adopter of a new technology. In this context, Foss et al. (2011) refer to an example of airlines that co-develop fuel-efficient airplanes to be in a position to faster adopt a new technology that reflects their formulated needs. Thus, working closely with a customer may reduce knowledge stickiness (Von Hippel 1988), which is known to impede innovation. Likewise, if a vendor has built the necessary capabilities to absorb sticky knowledge, this will benefit the vendor's innovation performance (Neale and Corkindale 1998).

In order to deliver hybrid offerings – and in contrast to pure goods or services – firms require specific capabilities such as a hybrid offerings deployment capability (Ulaga and Reinartz 2011). As a result, R&D and sales/consulting often work in tandem to capitalize on customization potentials. For example, sales or consulting personnel receives customer knowledge in multiple forms during their sales and implementation activities, which they then share with the R&D lab.

The interactions between customer contact personnel (e.g., sales, project manager, consultants) and R&D personnel imply that customer-derived knowledge reaches the R&D department directly. Thus, cross-functional communication as advocated by marketing scholars such as De Luca and Atuahene-Gima (2007) occurs naturally, through the design of hybrid offerings, even without explicit knowledge integration efforts. In essence, the interaction with customers should enhance the firm's goods innovation performance for hybrid offerings. We therefore expect to replicate prior findings regarding the positive relation between customer innovation and goods innovation (e.g., Foss et al. 2011) in that customer interaction is positively related to goods-related innovation performance in a hybrid offerings context.

H1a: For hybrid offerings, customer interaction is positively associated with firms' goods-related innovation performance.

Consistent with the services management view, pure services are co-created by providers and customers, which makes it difficult to separate production from consumption or measure service outcomes (Hipp and Grupp 2005, Ordanini and Parasuraman 2011). Service innovation is characterized by the ease of imitation by competitors as traditional protections of intellectual property (e.g., patents) are absent (Teece 1986). Despite easy imitability of service innovation, service-related knowledge is again sticky (Li 2012). Users know more about their needs than any vendor but they usually are either not capable to formulate their needs or do simply not know toward whom they should express their needs (Lettl 2007). Thus, applying the same rationale of how customer interaction benefits goods innovation performance seems appropriate for service elements in a hybrid offerings context. In short, because customer interactions help firms benefit from service-related knowledge about customer needs (Alam 2006, Matthing, Sandén, and Edvardsson 2004), interactions with customers are positively associated with service innovation outcomes (Ordanini and Parasuraman 2011). For hybrid offerings, we anticipate that the effects are not much different from those in pure service markets. That is, the direct link between customer interaction and service innovation should persist for hybrid offerings.

H1b: For hybrid offerings, customer interaction is positively associated with firms' service-related innovation performance.

Service Customization and Innovation Performance

Manufacturing firms use complementary services to varying degrees. Some firms are very goods-centric and offer services simply to support their products, such as installation, maintenance, or help desks (Antioco et al. 2008). Other manufacturing firms position themselves as service providers and even change their business and revenue models to feature customer-support services (Sharma et al. 2008), such as the fully outsourced management of product-related operations (Antioco et al. 2008, Eggert et al. 2013). Such firms often shift their revenue models, from pay per unit to pay per use.

Service providers usually seek service standardization, to benefit from economies of scale, but they are increasingly confronted with the need to customize their services to satisfy customers (Anderson, Fornell, and Rust 1997, Coelho and Henseler 2012). Customization refers to the degree to which a firm's offering is tailored to particular customer needs (Coelho and Henseler 2012, Wang, Wang, Ma, and Qiu 2010). Relatedly, Ulaga and Reinartz (2011) submit that managers in a hybrid offerings context strike a balance between efficiency and effectiveness by standardizing back-office processes and maintaining front-office customization since customized services usually require the deployment of additional resources (Rust and Huang 2012; Tuli, Kohli, and Bharadwaj 2007).

Typically, it is manufacturing firms that increase their level of service offerings to arrive at hybrid offerings (Höber and Schaarschmidt 2016). To this end, compared to goods customization, with which manufacturing firms are familiar, it may be surmised that service customization is rather new for firms that transform from pure manufacturing into solution providers (Eggert et al. 2013). One question that remains unaddressed in this context is if service customization affects goods- and service-related elements of a hybrid offerings differently. Customizing services expands the firm's access to customers' specific problem domains, such that it broadens the range of observations of use-related behavior, which in sum adds to the firm's market knowledge (Gwinner et al. 2005). These arguments suggest that a higher degree of customized services should benefit both goods and services innovation performance.

However, we submit that service customization might have different effects for goods- and service-related elements of hybrid offerings. Tailoring services to customers' needs will create access to service-related knowledge, and, to a lesser degree, to goods-related technological knowledge. For example, if a manufacturer customizes the service of maintenance by providing different service level agreements to different customers, the firm will learn how customers react to these service bundles but hardly enlarge its level of technological knowledge. In addition, customization involves investing additional resources (e.g., planning and executing service customization) which entails the well-known efficiency-satisfaction tradeoff (Anderson et al. 1997). Relying on resource based theorizing, there is reason to believe that when limited organizational resources are available, additional efforts pertaining to the customization of services will harm the firms capability to successfully transform technological knowledge into new goods. In other words, service-customization saps resources from goods development, which results in poorer goods innovation performance. Thus:

H2a: For hybrid offerings, the degree of service customization is positively associated with firms' service-related innovation performance.

H2b: For hybrid offerings, the degree of service customization is negatively associated with firms' goods-related innovation performance.

Mediating Role of Knowledge Integration Mechanisms

In management and marketing literature, much attention has been devoted to the role of knowledge integration mechanisms for superior innovation performance (e.g., De Luca and Atuahene-Gima 2007, Ruekert and Walker 1987, Zahra et al. 2000). Similar to absorptive capacity, an organizational-level capability (Kostopoulos et al. 2011), knowledge integration mechanisms refer to processes and structures that the firm has installed to route incoming knowledge (De Luca and Atuahene-Gima 2007). The extent to which a firm maintains knowledge integration mechanisms thus may correspond to or even result from the level of absorptive capacity that the firm possesses. Because firms may choose among different sets of knowledge integration mechanisms, such as information-sharing meetings, formal project analyses, and intentional cross-functional communication (De Luca and Atuahene-Gima 2007, Zahra et al. 2000), we apply a resource-based perspective and conceptualize the vendor's customer knowledge mobilization resources as a knowledge integration mechanism pivotal to hybrid offerings. In line with Ghosh, Dutta, and Stremersch (2006, p. 666), 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."

Extant literature suggests a mediating role for knowledge integration mechanisms in the customer interaction–innovation relationship (De Luca and Atuahene-Gima 2007). The mediating view implies that knowledge is a contingency factor that influences the design of knowledge integration mechanisms (De Luca and Atuahene-Gima 2007), suggesting an indirect effect and a significant relationship between the independent variable (i.e., customer interaction) and mediating variable (Baron and Kenny 1986). Support for this indirect effect comes from two observations. First, the tacit nature of knowledge demands appropriate knowledge integration mechanisms to ensure cross-functional knowledge exchange (De Luca and Atuahene-Gima 2007). Second, customer interactions affect the delegation of decision rights to employees, because managers have limited resources available to process information, which also constitutes a knowledge integration mechanism (Foss et al. 2011). Both arguments support the notion that customer knowledge affects the design of knowledge integration mechanisms.

This mediating view suggests that the innovation capability unfolds after the knowledge has been integrated into the organization (De Luca and Atuahene-Gima 2007). As goods-related elements of hybrid offerings are usually knowledge intensive, getting access to this knowledge through close customer interactions prompts firms to install knowledge integration mechanisms, which in turn foster innovation outcomes. Therefore, interactions with customers should affect the vendor’s customer knowledge mobilization resources and these, in turn, affect goods innovation performance, in line with the mediating view of knowledge integration mechanisms.

H3a: For hybrid offerings, firms’ customer knowledge mobilization resources mediate the direct relationship between customer interaction and goods-related innovation performance.

Few service firms have formal R&D departments (Djellal and Gallouj 2001), nor do manufacturing firms tend to maintain service-specific R&D departments. Thus, development processes for services are less structured than those for goods, requiring different sets of non-technical knowledge and shorter beta testing (Ettlie and Rosenthal 2011, Gallouj and Weinstein 1997).

Producing service innovations also requires less technological knowledge than does creating tangible products, which may explain why service firms can innovate without specific R&D laboratories. Most service innovations tend to be ad hoc and outside specific R&D processes as manufacturing firms just have started to include services in their offerings (Eggert et al. 2013). As industrial firms have not invested in service-specific R&D labs, little service-related knowledge integration mechanisms can be found. In addition, from a knowledge design perspective, service-related knowledge requires less formalization than technological knowledge, which also limits the need for formal knowledge integration mechanism. Taken together, we suggest:

H3b: For hybrid offerings, firms' customer knowledge mobilization resources do not mediate the direct relationship between customer interaction and service-related innovation performance.

Moderating Role of Technical Modularity

The effect of customer interaction on both goods and service innovation may depend on contingent factors, related to the nature of the good or service. A contingency factor that deserves increased attention is the goods' technical product modularity, which refers to "the intentional decoupling of interoperating subsystems of a larger system" (Tiwana 2008, p. 770). First, technical modularity is a design principle that can be actively managed by the vendor (Sanchez and Mahoney 1996). Second, technical product modularity affects knowledge integration designs through the structure of technical components (Dibiaggio 2007, Pil and Cohen 2006). Third, and most importantly, technical modularity is a prerequisite for providing customized technical solutions efficiently as from modular architectures a wide variety of products can be configured and assembled (Mikkola 2007).

Technical product modularity simplifies the sale of customized solutions, such as hybrid offerings (Ghosh et al. 2006). When the offered good's technical modularity is low, a firm must invest more resources to provide a customized solution. In turn, high modularity favors customization. On the other hand, modularity is costly to produce as it involves investments in product architecture, which result in a potential trade-off between costs and benefits of modularity (Brusoni et al. 2007, Cabigiosu and Camuffo 2012).

From a communication perspective, technical product modularity may also be seen as a means to help reducing system complexity (Baldwin and Clark 2000, Tiwana 2008). Instead of having to understand the whole system at once, people involved in customization can gradually comprehend system components, which should facilitate their ability to communicate with each other. For example, sales and customization personnel can start interacting with customers based on modular sub-components instead of an entire system. Thus, technical product modularity may strengthen inter- and intra-organizational communication thereby substituting organizational knowledge integration designs.

We propose that technical modularity affects the link from customer interaction to innovation performance when modularity is moderate but to a lesser degree when it is low or high. Ghosh et al. (2006) maintain that when modularity is low, the vendor has much better knowledge than the customer has on the specification of interfaces between components. Thus, when modularity is low, it has not the potential to support customer interaction-enabled innovation performance-enhancing knowledge transitions from the customer to the vendor. In cases of high modularity though, the architecture of a product unlocks the customer interaction potentials. When firms offering highly modularized sub-components interact with customers this will, ceteris paribus, benefit both goods and services innovation. However, high modularity might also be a liability. Apart from the costs associated with creating modular offerings, high modularity increases the need for cross-modular communication (Campagnolo and Camuffo 2010), which may detrimentally affect innovation performance.

We submit that customer interaction is most valuable in terms of innovation performance when modularity is moderate, thus, suggesting an inverted U-shaped moderating effect. At intermediate levels of technical modularity, we expect a balance to exist between the benefits of modularity in terms of facilitating communication and creativity and its downside reflected by increasing coordination needs and less autonomy.

H4a: For hybrid offerings, the relationship between customer interaction and firms' goods-related innovation performance is strongest under intermediate levels of technical modularity, but comparatively weaker when technical modularity is low or high.

H4b: For hybrid offerings, the relationship between customer interaction and firms' service-related innovation performance is strongest under intermediate levels of technical modularity, but comparatively weaker when technical modularity is low or high.

METHODS

Sample and Data Collection

This study focuses on industrial firms that offer both goods and services in B2B settings and provide offerings predominantly through customization projects that require intense customer interaction. Both manufacturing and IT firms meet these criteria. We conducted 17 initial, semistructured interviews with representatives of manufacturing and IT firms to learn about their personal views on the importance of services for goods-oriented companies, the evolution of their industry, and the role of customer interactions. The interviews also touched on the important roles of customization and product architecture and confirmed that experts could distinguish goods innovation from service innovation. Each interview, which lasted an average of 60 minutes, featured either the firm's CEO or the head of R&D.

To identify potential participants for the main study, we purchased mailing and information lists of manufacturing and IT firms in Germany, Austria, and Switzerland from two independent information vendors. The merged samples produced a final sample of 3,000 firms with more than 10 employees in the manufacturing and IT sectors, according to the German WZ ("Wirtschaftszweige") industry code (WZ 2008: 262xx, 263xx, 271xx, 284xx, 289xx, 291xx, 6201x), which reflects the pan-European NACE code. We contacted the head of R&D or, in the absence of an R&D department, the CEO of these firms via e-mail and asked them to complete an online questionnaire. Of these messages, 345 could not be delivered due to outdated e-mail addresses; the remaining 2,655 invitations were sent in three rounds, with one reminder e-mail per round. We received 406 responses for a response rate of 15.3%, similar to previous surveys in the field (Carbonell et al. 2009). Moreover, the response rate found here resonates the decline in response rates for organization studies as highlighted by Baruch and Holtom (2008).

However, we had to exclude a considerable number of responses for various reasons. First, about 150 participants abandoned the survey after five minutes, thus rendering the data useless. Second, we excluded all responses from informants that indicated to work in business-to-consumer contexts and that stated they would sell 100% goods. Thus, this procedure limited the analysis sample to 146 firms, also similar in size to previous investigations (Antioco et al. 2008).

To assess non-response bias, for each round of invitations, we compared the first 25% of responses with the last 25% but found no significant differences in the reflective constructs (Armstrong and Overton 1977).

Measures

Dependent, independent, mediator, and moderator variables. The unit of analysis for this study is the firm. To measure customer interaction, vendor customer knowledge mobilization resources, technical product modularity, and goods and service innovation performance, we relied on existing measures (see the Appendix). The anchor points for each seven-point scale were "strongly disagree" (1) and "strongly agree" (7), with the exception of customer interaction, which used "not at all" (1) and "to a very large extent" (7). Because the survey was conducted in German-speaking countries, we translated the original items into German, then retranslated them into English with the help of native speakers (Brislin 1970); no misunderstanding occurred.

To measure *customer interaction*, we used three items from Foss et al. (2011). Previous studies have explicitly investigated the degree to which customers are integrated into new product development processes (Carbonell et al. 2009), but we focus on the interaction with customers during the customization project, which spans a continuum from high to low. To examine *goods innovation performance*, we adapted a four-item scale (Song et al. 2006). For *service innovation performance*, we relied on three items from Storey and Kahn (2010). For both measures of innovation performance, we provided respondents with a text that clearly stated that their answers were sought in relation to goods-related and service-related innovation performance in a hybrid offerings context along with examples.

To capture *vendors' customer knowledge mobilization resources*, we used four of the original nine items by Ghosh et al. (2006). The choice of items was motivated by their fit with hybrid offering scenarios. To assess technical product modularity, we relied on three items from Ghosh et al. (2006). Regarding modularity, we ensured that respondents reported the average modularity of the products they sold most. We used a single-item measure of service customization; we showed participants a list of eleven services that support the product such as maintenance or help desk (Antioco et al. 2008), and asked: "On average, how intensely do you customize these kinds of services to your customers?" (1 = "not at all", 7 = "to a very large extend).

Controls. We controlled for six potential influences: the firm's R&D intensity, customer relationship management (CRM) intensity, size, industry, country, and percentage of service turnover. *R&D intensity* was measured as the percentage of revenue devoted to R&D. Because firms' intensity of collaboration with customers and firm performance might depend on their CRM (Reinartz, Krafft, and Hoyer 2004), we controlled for *CRM intensity* as a percentage of revenue spent on CRM activities. *Firm size* may affect both goods and service innovation, because larger firms tend to realize higher absorptive capacities (Kostopoulos et al. 2011). To control for it, we included the logarithm of the firm's annual revenue and the number of employees. First, for revenue, we determined the firm's revenue in the previous year in millions of Euros, which was available for 61 of our 146 sample firms, then compared their reported with real revenue values. The maximal deviation was less than 5%, so the self-reported revenue values appeared valid. Then to account for skewness, we took the logarithm of the revenue value. Second, the number of employees was an interval measure, from 1 to 7 (10–50 employees, 51–100 employees, 101–250 employees; 251–500 employees; 501–1,000 employees; 1,001–10,000 employees, more than 10,000 employees). Unlike previous innovation studies (e.g., Stock 2011), we used comparatively low scale anchors, in line with the software firms' characteristics (i.e., few employees).

Although our investigation was limited to IT and manufacturing industries, our approach still was cross-industrial. Different industries might exhibit different levels of innovation performance for both goods and services (Leiponen and Helfat 2010). Therefore, we controlled for *industry* by including a dummy variable (1 = IT industry; 0 = not IT industry). We further controlled for *country* differences by including dummy variables for Austria and Switzerland. Finally, we controlled for the percentage of *service turnover* as firms with high revenue from services might be more focused on service innovation than rather goods-oriented firms.

Reliability, Validity, and Common Method Bias

The means, standard deviations, and correlation coefficients appear in Table 1.

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The reliability of all reflective scales was satisfactory, with Cronbach's α values ranging from .70 to .88 and composite reliability values ranging from .82 to .93 (see the Appendix), which exceeded the recommended thresholds of .7 and .8, respectively (Nunnally and Bernstein 1994). For measurement validation, we conducted a confirmatory factor analysis of 14 indicators representing customer interaction, vendor customer knowledge mobilization resources, goods innovation performance, and service innovation performance using AMOS 23. The four-factor measurement model revealed an acceptable fit with the data ($\chi^2 = 117.70$, df = 66, χ^2/df = 1.783 [$p < .000$], goodness-of-fit index = .90, comparative fit index = .92, Tucker-Lewis index = .92, root mean square error of approximation = .07; Kline 1998). All fit values were appropriately above or below their recommended thresholds (Bagozzi and Yi 1988). In support of discriminant validity, the average variance extracted (AVE) exceeded the recommended threshold of .5 for each construct, and the correlation between any pair of unobserved variable was smaller than the square root of AVE per construct (Fornell and Larcker 1981).

We used the same sample to measure independent, dependent, and mediating constructs, so the constructs may share systematic covariance, and common method variance (CMV) could challenge the validity of our results (Podsakoff et al. 2003). We used ex-ante and ex-post techniques to limit and control for CMV. To reduce the possibility of item ambiguity, we pretested the questionnaire with five managers from both IT and manufacturing companies. In addition, we used different scale anchors for predictor (i.e., customer interaction) and criterion (i.e., goods and services innovation performance) variables.

To assess the level of CMV bias, we conducted Harman's single-factor test (Podsakoff, MacKenzie, and Podsakoff 2012). However, the single-factor model yielded an unacceptable fit ($\chi^2/df = 6.327$, $p < .000$, RMSEA = .192). We also applied the approach suggested by Lindell and Whitney (2001) and used a theoretically independent marker variable, which we measured with three items. Lindell and Whitney (2001) argue that the smallest correlation among the model variables (including the marker variable) may function as a proxy for CMV. If any significant positive correlation between constructs is no longer significant after removing the factor with the smallest correlation, CMV likely harms the validity of the results. Because we observed no differences in the levels of significance, we do not consider CMV a major concern in this study.

RESULTS

We used ordinary least square regressions and the SPSS macro PROCESS to test the hypotheses (Table 2). The advantage of PROCESS involves testing mediation and moderation effects simultaneously and applying bootstrapping for indirect effects (Hayes 2013)[2]. Prior to calculating the interaction effects, we mean centered the predictor and moderator variables (Dalal and Zickar 2012). We also tested for the multicollinearity of the predictor variables by calculating the variance inflation factor for all our models. The highest value was 2.774 for the squared interaction term in Model 6, suggesting that multicollinearity was not an issue (Diamantopoulos and Siguaw 2006).

--- *Please insert Table 2 about here* ---

Table 2 presents the regression results. In Model 1, goods innovation is regressed on all control variables. None of the controls is significantly related to goods innovation. Model 2 includes all controls and independent variables. Here, customer interaction is positively associated with goods innovation ($b = .16$, $p < .05$), in support of H1a. Service customization has a slightly negative effect on goods innovation, as predicted. Finally, Model 3 presents the full model including the mediator variable and the interaction terms. Here, customer interaction is

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[2] We also employed structural equation modeling with AMOS 23 and a maximum likelihood estimator to replicate the findings for the direct and indirect effects. A model with customer interaction, vendors' customer knowledge mobilization resources, services and goods innovation revealed results comparable to PROCESS [$\chi^2 = 143.80$, df = 72, $\chi^2/df = 1.997$, GFI = .89, CFI = .92, TLI = .89, RMSEA = .08]. In particular, customer interaction was significantly related to vendors' customer knowledge mobilization resources, services and goods innovation. The indirect effect of customer interaction on goods innovation was significant, while the indirect effect on services innovation was not.

still positively associated with goods innovation ($b = .19$, $p < .05$), while service customization has a negative relation ($b = -.16$, $p < .05$), supporting H1a and H2a. In addition, vendor's customer knowledge mobilization resources have a strong positive effect on goods innovation ($b = .32$, $p < .001$), a result that points to mediation. To further quantify the strength of the indirect effect, bootstrapping with 1000 bootstrap samples was applied (Preacher and Hayes 2008). A bootstrap interval that does not comprise zero indicates that the indirect effect of customer interaction on goods innovation through vendor's customer knowledge mobilization resources is significant (LLCI: .04, ULCI: .18). This finding supports the mediating hypothesis H3a. For testing H4a, an interaction variable was built by multiplying customer interaction and the squared term of technical modularity. As this interaction has no significant effect, we have to reject H4a.

Regarding the relation between customer interaction and service innovation performance, we found a significant and positive effect ($b = .23$, $p < .05$, Model 5). We also found a significant and positive effect of service customization ($b = .26$, $p < .05$, Model 5). Together, these results support H1b and H2b. As vendor's customer knowledge mobilization resources do not exhibit a significant relation to service innovation ($b = .19$, *n.s.*, Model 5), a prerequisite for mediation is violated, thus indicating that H3b has to be rejected. A bootstrap interval that comprises zero further supports this rejection (LLCI: -.01, ULCI: .15, Model 5). Notably, the percentage of revenue from services, a control variable, has a small significant effect on service innovation ($b = .01$, $p < .05$, Model 5), indicating that the extent to which a firm offers services is related to the service innovation performance.

Finally, service innovation was regressed on the interaction term of customer interaction and technical modularity squared (Model 6). All previous results remain stable. In addition, the interaction term was negative and significant ($b = -.18$, $p < .05$, Model 6). This significant path indicates that the relation between customer interaction and service innovation in a hybrid offerings context is contingent on the technical modularity (cf. Schilke 2014). Moreover, the negative sign indicates that the relation's strength is inverted U-shaped. Figure 2 illustrates the relation.

--- *Please insert Figure 2 and Table 3 about here* ---

For low levels of customer interaction, technical modularity is more beneficial in terms of eliciting service innovation if it is high than if it is low. Thus, for low customer interaction, no inverted U-shape relation exits. However, for high levels of customer interaction, an inverted U-shape relation can be observed, in partial support of H4b. Table 3 summarizes the hypotheses tests results.

DISCUSSION

This research has aimed to address the gap in the services literature related to the customer interaction–innovation link for hybrid offerings. Despite their growing relevance, scarce knowledge clarifies the path by which customer interactions positively shape hybrid innovation performance. For example, Homburg and Kuehnl (2014) have investigated how customer interaction is related to innovation in both goods and service sectors, but no research exists that has taken into account goods and service elements of the same bundled offering. Research thus must consider the changing landscapes of firms' value delivery modes that involve both goods and services. In goods-oriented markets, services have evolved from supporting the goods offering to serving the customer and thus generating rents and stabilized revenue streams (Antioco et al. 2008). Drawing on resource-based theory and the model of customer interaction–induced innovation, we confirm that customer interaction drives goods- and services innovation performance in a hybrid offerings context. Notably, we find a mediating role of vendors' customer knowledge mobilization resources for goods innovation but not for services innovation. We also investigated the role of service customization and found that it favors service innovation but impedes goods innovation in a hybrid offerings context. Finally, the important role of technological modularity as an enabler of customization was unfolded. In particular, the results suggest that the link from customer interaction to service innovation is strongest for intermediate levels of technical modularity. Thus, our research builds on and extends research that has explored the role of customer interaction in innovation processes by distinguishing goods from service elements of hybrid offerings.

Theoretical Implications

Research into the role and importance of external knowledge for successful innovations advocates close interaction and even the integration of external knowledge sources (Chesbrough, 2003), including universities, external research laboratories, and customers. In most consumer markets, customer interactions are limited to short sales processes. Thus, to tap customer knowledge, firms need to interact with them more meaningfully such as through lead user workshops (Schaarschmidt and Kilian 2014). With hybrid offerings in business markets, customer interactions span a relatively long period in which firms access customer knowledge without formally integrating them into R&D activities. To this end, this study's results suggest rethinking established concepts, such as absorptive capacity (Todorova and Durisin 2007) and cross-functional collaboration (De Luca and Atuahene-Gima 2007), which may be less applicable to the context of hybrid offerings. Distinguishing between a goods oriented and a service oriented absorptive capacity could be a fruitful area of future theoretical work.

Furthermore, as the pertinent literature maintains, firms need knowledge integration mechanisms to appropriate from customer knowledge (De Luca and Atuahene-Gima 2007). For hybrid offerings, we similarly find a mediation of the customer interaction–innovation link by knowledge integration mechanisms (i.e., vendor's customer knowledge mobilization resources), but only for goods and not for services elements of hybrid offerings. Therefore, further research should account carefully for the differences in knowledge required to generate goods and services innovations, especially in a hybrid offering context. For example, researchers might investigate how customer knowledge transforms into different types of market knowledge, such as breadth, depth, tacitness, and specificity, as well as the effects on innovations.

Our results extend innovation research by clarifying the contingencies of the relationship between customer interaction and innovation performance. Technical product modularity has been shown to be partly responsible for a curvilinear effect of customer interaction on services innovation. Interestingly, the curvilinear effect is only visible for high customer interaction scenarios; a finding that supports the notion of modularity as a design that affects communication. This result heeds the call for analyzing more non-linear effects in innovation research (Homburg and Kuehnl 2014), but also might prompt further research devoted to the interplay of organizational processes and product architecture in a hybrid offerings context.

Finally, the results of this study imply that more research is needed that identifies capabilities necessary to provide hybrid offerings. For example, future research could clarify the nature and dimensionality of a "hybrid offerings alignment capability", that is, a firm's capability to effectively align goods and service innovation. As goods and services usually have different lifetime, such research would advance our knowledge in the nascent field of hybrid offerings.

Managerial Implications

Customer interaction is a central success factor for both goods and services innovation performance (Bonner and Walker 2004, Ordanini and Parasuraman 2011); we show that it also affects hybrid offerings. That is, in hybrid offering contexts, customer interactions can directly or indirectly affect innovation performance on the good or service component. The results of this study thus have implications for innovation management in firms designing hybrid offerings. For example, to promote innovation in hybrid offerings, firms must develop selling strategies that foster high levels of interaction with the customer. This implies investing in the training of sales teams, conducting more pre- and post-project workshops, and establishing communication lines that enable an effective flow of information from the customer to the firm.

Our study also acknowledges that customer knowledge affects knowledge integration designs, because firms form processes and structures to integrate external knowledge into R&D activities in response to the tacit nature of knowledge (De Luca and Atuahene-Gima 2007). Once the firm has installed knowledge integration mechanisms, their value increases for innovating goods rather than services. Furthermore, firms that have just started to expand their service portfolio must realize that processes that support the integration of technical knowledge for goods innovation may not support a similar integration for new services. Thus, our results suggest the need for service-specific knowledge integration processes, including performance measurement approaches (Nachum 1999).

Moreover, firms' dependence on services, as indicated by the share of service revenue, relates directly to service innovation performance. If they plan to evolve from pure goods providers to service providers, firms must recognize how their competition shifts as well towards services. Our results imply that firms must ensure they are ready to compete with services—

including possessing an ability to develop service innovations—before expanding their service offerings or changing their business model (Zott, Amit, and Massa 2011). Furthermore, firms that move into services should install feedback cycles to route customer knowledge reported to customer contact personnel formally to service-oriented R&D departments.

Finally, managers might be interested to learn what other factors affect innovation outcomes. First, according to our results, service customization constitutes a way to foster service innovations but not goods innovation. Even worse, our results reveal that service customization negatively affects goods innovation. This insight calls for carefully balancing service innovation efforts in the future. Relatedly, this study's results suggest that technical product modularity is a factor that shapes how customer interaction fosters innovation outcomes. Especially for service innovations, firms must develop ways to identify the level of technical modularity in their offerings, as moderate levels of modularity seem to boost knowledge transfer from the customer to the firm.

Limitations and Further Research

Some limitations of this study suggest avenues for research. First, we relied on key informants from different organizations (Homburg et al. 2012). However, additional studies might consider surveying multiple respondents from the same organization to arrive at a more stable picture of goods and services innovation in a firm. Second, and relatedly, we addressed CMV by applying several checks but it would have been better to use different sources of data for the independent and dependent variables. Third, we did not consider the costs of implementing organizational practices, such as customer knowledge mobilization resources. Further studies might identify the optimal levels of customer interaction that balance knowledge benefits against costs. Finally, our measures of innovation performance do not capture long-term success. Future work could replicate our findings by using success measures that are long-term oriented.

Conclusion

Until now, research has predominantly addressed innovation activities either in a pure goods or in a pure services context. This research began by first delineated how innovating hybrid offerings differs from both innovating pure goods and pure services. Then, a study among IT and manufacturing firms that offer bundles of goods and services revealed that customer interaction is conducive to innovation for both the tangible and service-related part of a hybrid offering. However, the study also revealed potential trade-offs. Service customization, while beneficial to service innovation, negatively affects goods innovation. In addition, while vendors' customer knowledge integration mechanisms are important to transform customer knowledge into goods innovation, they do not affect how customer knowledge converts into service innovation. Thus, this study is among the first to unravel innovation processes in a hybrid offerings context.

REFERENCES

Aarikka-Stenroos, Leena, and Elina Jaakkola (2012). “Value co-creation in knowledge intensive business services: A dyadic perspective on the joint problem solving process,” *Industrial Marketing Management,* 41(1), 15-26.

Alam, Ian (2006), “Removing the fuzziness from the fuzzy-end of service innovations through customer interactions,” *Industrial Marketing Management*, 35(4), 468–480.

Anderson, Eugene W., Claes Fornell, and Roland T. Rust (1997), “Customer satisfaction, productivity, and profitability: Differences between goods and services,” *Marketing Science*, 16, 129-145.

Antioco, Michael, Rudy K. Moenaert, Adam Lindgreen, and Martin G.M. Wetzels (2008), “Organizational antecedents to and consequences of service business orientation in manufacturing companies,” *Journal of the Academy of Marketing Science*, 36, 337-358.

Armstrong, J. Scott and Terry S. Overton (1977), “Estimating non-response bias in mail surveys,” *Journal of Marketing Research*, 14, 396-402.

Atuahene-Gima, Kwaku (1995), “An exploratory analysis of the impact of market orientation on new product performance: A contingency approach,” *Journal of Product Innovation Management*, 12 (September), 275-293.

------ (2005), “Resolving the capability-rigidity paradox in new product innovation,” *Journal of Marketing*, 69, 61-83.

Bagozzi, Richard P. and Youjae Yi (1988), “On the evaluation of structural equation models,” *Journal of the Academy of Marketing Science*, 16(1), 74–94.

Baldwin, Carliss Y. and Kim B. Clark (2000), *Design Rules: The Power of Modularity*. Cambridge: MIT Press.

Baron, Reuben M. and David A. Kenny (1986), “The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations,” *Journal of Personality and Social Psychology*, 51(6), 1173-1182.

Bartl, Michael, Johann Füller, Hans Mühlbacher, and Holger Ernst (2012), “A manager’s perspective on virtual customer integration for new product development,” *Journal of Product Innovation Management*, 29(6), 1031-1046.

Bonner, Joseph M. and Orville C. Walker (2004), “Selecting influential business-to-business customers in new product development: Relational embeddedness and knowledge heterogeneity considerations,” *Journal of Product Innovation Management*, 21(3), 155-169.

Brislin, Richard W. (1970), “Back-translation for cross-cultural research,” *Journal of Cross-Cultural Psychology*, 1(3), 185-216.

Brusoni, Stefano, Luigi Marengo, Andrea Prencipe, and Marco Valente (2007), “The value and costs of modularity: a problem-solving perspective,” *European Management Review*, 4(2), 121-132.

Cabigiosu, Anna and Arnaldo Camuffo (2012), “Beyond the ‘Mirroring Hypothesis’: Product Modularity and Interorganizational Relations in the Air Conditioning Industry,” *Organization Science*, 23(3), 686-703.

Campagnolo Diego and Arnaldo Camuffo (2010), “The Concept of Modularity in Management Studies: A Literature Review,” *International Journal of Management Reviews*, 12 (3), 259–283.

Carbonell, Pilar, Ana .I. Rodríguez-Escudero, and Devashish Pujari (2009), "Customer involvement in new service development: An examination of antecedents and outcomes," *Journal of Product Innovation Management*, 26, 536-550.
Chatterji, Aaron K. and Kira Fabrizio (2012), "How do product users influence corporate nvention?," *Organization Science*, 23(4), 971-987.
Chen, Ja-Shen, Hung-Tai Tsou, and Russell K.H. Ching (2011), "Co-production and its effects on service innovation," *Industrial Marketing Management*, 40, 1331-1346.
Chesbrough, Henry (2003), "The logic of open innovation: Managing intellectual property," *California Management Review*, 45, 33-58.
------ (2011), *Open Service Innovation: Rethinking Your Business to Grow and Compete in a New Area.* San Francisco, CA: Jossey-Boss.
Coelho, Pedro S. and Jörg Henseler (2012), "Creating customer loyalty through service customization," *European Journal of Marketing*, 46(3/4), 331-356.
Coviello, Nicole E. and Richard M. Joseph (2012), "Creating major innovations with customers: Insights from small and young technology firms," *Journal of Marketing*, 76(6), 87-104.
Dalal, Dev K. and Michael J. Zickar (2012), "Some common myths about centering predictor variables in moderated multiple regression and polynomial regression," *Organization Research Methods*, 15(3), 339-362.
Day, George S. (1994), "The capabilities of market-driven organizations," *Journal of Marketing*, 58(4), 37-52.
De Luca, Luigi M. and Kwaku Atuahene-Gima (2007), "Market knowledge dimensions and cross-functional collaboration: Examining the different routes to product innovation performance," *Journal of Marketing*, 71(1), 95-112.
Diamantopoulos, Adamantios and J.A. Siguaw (2006), "Formative versus reflective indicators in organizational measure development: A comparison and empirical illustration," *British Journal of Management*, 17(4), 263-282.
Djellal, Faridah and Faïz Gallouj (2001), "Patterns of innovation organization in service firms: Portal survey results and theoretical models," *Science and Public Policy*, 28(1), 57-67.
Eggert, Andreas, Jens Hogreve, Wolfgang Ulaga, and Eva Muenkhoff (2013), "Revenue and profit implications of industrial service strategies," *Journal of Service Research*, 17(1), 23-39.
Ettlie, John E. and Stephen R. Rosenthal (2011), "Services versus manufacturing innovation," *Journal of Product Innovation Management*, 28, 285-299.
Evanschitzky, Heiner, Florian Von Wangenheim, and David Woisetschläger (2011), "Service & Solution Innovation: Overview and Research Agenda," *Industrial Marketing Management*, 40 (5), 657-660.
------, Martin Eisend, Roger J. Calantone, and Yuanyuan Jiang (2012), "Success factors of product innovation: An updated meta-analysis," *Journal of Product Innovation Management*, 29(S1), 21-37.
Fang, Eric (2008), "Customer participation and the trade-off between new product innovativeness and speed to market," *Journal of Marketing*, 72(4), 90-104.
------, Robert G. Palmatier, and Jan-Benedict E.M. Steenkamp (2008), "Effect of service transition strategies on firm value," *Journal of Marketing*, 72(5), 1-14.
Fornell, Claes and David F. Larcker (1981), "Evaluating structural equation models with unobservable variables and measurement error," *Journal of Marketing Research*, 18(1), 39-50

Foss, Nicolai J., Keld Laursen, and Torben Pedersen (2011), "Linking customer interaction and innovation: The mediating role of new organizational practices," *Organization Science*, 22(4), 980-999.

Franke, Nikolaus, Eric Von Hippel, and Martin Schreier (2006), "Finding commercially attractive user innovations: A test of lead-user theory," *Journal of Product Innovation Management*, 23(4), 301-315.

Gallouj, Faïz and Olivier Weinstein (1997), "Innovation in services," *Research Policy*, 26, 537-556.

Gebauer, Heiko, Anders Gustafsson, and Lars Witell (2011), "Competitive advantage through service differentiation by manufacturing companies," *Journal of Business Research*, 64(12), 1270-1280.

Ghosh, Mrinal, Shantanu Dutta, and Stefan Stremersch (2006), "Customizing complex products: When should the vendor take control?," *Journal of Marketing Research*, 43, 664-679.

Gwinner, Kevin P., Mary Jo Bitner, Stephen W. Brown, and Ajith Kumar (2005), "Service customization through employee adaptiveness," *Journal of Service Research*, 8(2), 131-148.

Hayes, Andrew F. (2013), *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach*. New York: Guilford Press.

Hipp, Christian and Hariolf Grupp (2005), "Innovation in the service sector: The demand for service-specific innovation measurement concepts and typologies," *Research Policy*, 34(4), 517-535.

Höber, Björn and Mario Schaarschmidt (2016), "Transforming from Service Providers to Solution Providers – Implications for Customer-Provider Relationships and Customer-induced Solution Innovation," *International Journal of Technology Management*, forthcoming

Homburg, Christian, Martin Klarmann, Martin Reimann, und Oliver Schilke (2012), "What drives key informant accuracy?," *Journal of Marketing Research*, 49(4), 594-608.

------ and Christina Kuehnl (2014), "Is the more always better? A comparative study of internal and external integration practices in new product and new service development," *Journal of Business Research*, 67(7), 1360-1367.

Huston, Larry and Nabil Sakkab (2006), "Connect and develop: Inside Procter & Gamble's new model for innovation," *Harvard Business Review*, 84(3), 58-66.

Kale, Prashant and Harbir Singh (2007), "Building firm capabilities through learning: The role of the alliance learning process in alliance capability and firm-level alliance success," *Strategic Management Journal*, 28, 981-1000.

Kline, Rex B. (1998), *Principles and Practice of Structural Equation Modeling*. New York: Guilford Publications.

Kohli, Ajay K. and Bernard J. Jaworski (1990), "Market orientation: The construct, research propositions, and managerial implications," *Journal of Marketing*, 54, 1-18.

Kostopoulos, Konstantinos, Alexandros Papalexandris, Margarita Papachroni, and George Ioannou (2011), "Absorptive capacity, innovation, and financial performance," *Journal of Business Research*, 64, 1335-1343.

Lau, Antonio K.W., Esther Tang, and Richard C.M. Yam (2010), "Effects of supplier and customer integration on product innovation and performance: Empirical evidence in Hong Kong manufacturers," *Journal of Product Innovation Management*, 27(5), 761-777.

Laursen, Keld and Ammon Salter (2006), “Open for innovation: The role of openness in explaining innovation performance among U.K. manufacturing firms,” *Strategic Management Journal*, 27, 131-150.
Leiponen, Aija and Constance E. Helfat (2010), “Innovation objectives, knowledge sources, and the benefits of breadth,” *Strategic Management Journal*, 31(2), 224–236.
Lettl, Christopher (2007), “User involvement competence for radical innovation,” *Journal of Engineering and Technology Management*, 24(1-2), 53-57.
Li, Chia-Ying (2012), “Knowledge stickiness in the buyer–supplier knowledge transfer process: The moderating effects of learning capability and social embeddedness,” *Expert Systems with Applications*, 39(5), 5396-5408.
Lindell, Michael K. and David J. Whitney (2001), “Accounting for common method variance in cross-selectional research designs,” *Journal of Applied Psychology*, 86(1), 114-121.
Matthing, Jonas, Bodil Sandén, and Bo Edvardsson (2004), “New service development: learning from and with customers,” *International Journal of Service Industry Management*, 15(5), 479-498.
Mikkola, Juliana H. (2007), “Management of product architecture modularity for mass customization: modeling and theoretical considerations,” *IEEE Transactions on Engineering Management*, 54(1), 57-69.
Nachum, Lilach (1999), “The productivity of intangible factors of production–Some measurement issues applied to Swedish management consulting firms,” *Journal of Service Research*, 2(2), 123-137.
Neale, Michael R. and David R. Corkindale (1998), “Co-developing products: Involving customers earlier and more deeply,” *Long Range Planning*, 31(3), 418–425.
Noordhoff, Corine S., Kyriakos Kyriakopoulos, Christine Moorman, Pieter Pauwels, and Benedict G.C. Dellaert (2011), “The bright and the dark side of embedded ties in business-to-business innovation,” *Journal of Marketing*, 75(3), 34-52.
Nunnally, Jum C. and Ira H. Bernstein. 1994. *Psychometric Theory*. New York: McGraw-Hill.
Ngo, Liem Viet and Aron O’Cass (2013), “Innovation and business success: The mediating role of customer participation,” *Journal of Business Research*, 66(8), 1134-1142.
Ordanini, Andrea and A. Parasuraman (2011), “Service innovation viewed through a service-dominant logic lens: A conceptual framework and empirical analysis,” *Journal of Service Research*, 14(1), 3-23.
Payne, Adrian F., Kaj Storbacka, and Pennie Frow (2008), “Managing the co-creation of value,” *Journal of the Academy of Marketing Science*, 36(1), 83-96.
Podsakoff, Philip M., Scott B. MacKenzie, Jeong-Yeon Lee, and Nathan P. Podsakoff (2003), “Common method biases in behavioral research: A critical review of the literature and recommended remedies,” *Journal of Applied Psychology*, 88(5), 879-903.
------, Scott B. MacKenzie, and Nathan P. Podsakoff (2012), “Sources of method bias in social science research and recommendations how to control it,” *Annual Review of Psychology*, 63, 539-569.
Preacher, Kristopher J. and Andrew F. Hayes (2008), “Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models,” *Behavior research methods*, *40*(3), 879-891.

Ruekert, Robert W. and Orville C. Walker, Jr. (1987), "Interactions between marketing and R&D departments in implementing different business strategies," *Strategic Management Journal*, 8, 233-248.
Rust, Roland T. and Ming-Hui Huang (2012), "Optimizing service productivity," *Journal of Marketing*, 76, 47-66.
Sanchez, Ron and Joseph T. Mahoney (1996), "Modularity, flexibility, and knowledge management in product and organization design," *Strategic Management Journal*, 17(Winter), 63-76.
Sawhney, Mohanbir, Gianmario Verona, and Emanuela Prandelli (2005), "Collaborating to create: The Internet as a platform for customer engagement in product innovation," *Journal of Interactive Marketing*, 19(4), 4-17.
Schaarschmidt, Mario and Thomas Kilian (2014), "Impediments to customer integration into the innovation process: A case study in the telecommunications industry," *European Management Journal*, 32(2), 350–361.
Schilke, Oliver (2014), "On the contingent value of dynamic capabilities for competitive advantage: The nonlinear moderating effect of environmental dynamism," *Strategic Management Journal*, 35, 179-203.
Shankar, Venkatesh, Leonard L. Berry, and Thomas Dotzel (2007), "Creating and managing hybrid innovations," *Presentation at AMA Winter Educators' Conference*, San Diego, CA, (February 16–19). Available at http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.133.1657&rep=rep1&type=pdf
------, Loenard. L. Berry, and Thomas Dotzel (2009), "A practical guide to combining products and services," *Harvard Business Review*, 87(11), 94-99.
Sharma, Arun, Gopalkrishnan R. Iyer, and Heiner Evanschitzky (2008), "Personal selling of high technology products: The solution-selling imperative," *Journal of Relationship Marketing*, 7(3), 287-308.
Song, Michael, Barbara Dyer, and R. Jeffrey Thieme (2006), "Conflict management and innovation performance: An integrated contingency perspective," *Journal of the Academy of Marketing Science*, 34, 341–356.
------, Tang Wang, and Mark E. Parry (2010), "Do market information processes improve new venture performance?," *Journal of Business Venturing*, 25(6), 556-568.
Stock, Ruth Maria (2011), "How does product program innovativeness affect customer satisfaction? A comparison of goods and services," *Journal of the Academy of Marketing Science*, 39, 813-827.
Storey, Chris and Kenneth B. Kahn (2010), "The role of knowledge management strategies and task knowledge in stimulating service innovation," *Journal of Service Research*, 13(4), 397-410.
Teece, David J. (1986), "Profiting from technological innovation: Implications for integration, collaboration, licensing, and public policy," *Research Policy*, 15(6), 285-305.
The Guardian (2016), "Motorola brand to cease to exist," URL, http://www.theguardian.com/technology/2016/jan/08/motorola-brand-killed-off-lenovo, last access Januray 8th, 2016
Tiwana, Amrit (2008), "Does technological modularity substitute for control? A study of alliance performance in software outsourcing," *Strategic Management Journal*, 29, 769-780.

Todorova, Gergana and Boris Durisin (2007), "Absorptive capacity: Valuing a reconceptualization," *Academy of Management Review*, 32(2), 774-786.

Tuli, Kapil R., Ajay K. Kohli, and Sundar G. Bharadwaj (2007), "Rethinking customer solutions: From product bundles to relational processes," *Journal of Marketing*, 71, 1-17.

Ulaga, Wolfgang and Werner J. Reinartz (2011), "Hybrid offerings: How manufacturing firms combine goods and services successfully," *Journal of Marketing*, 75(6), 5-23.

Vargo, Stephen L. (2008), "Customer integration and value creation: Paradigmatic traps and perspectives," *Journal of Service Research*, 11, 211-215.

------ and Robert F. Lusch (2008), "Service-dominant logic: Continuing the evolution," *Journal of the Academy of Marketing Science*, 36, 1-10.

Von Hippel, Eric (1978), "Successful industrial products from customer ideas," *Journal of Marketing*, 42(1), 39-49.

------ (1994), "Sticky information and the locus of problem solving," *Management Science*, 40, 429-439.

Wang, Guangping, Jianling Wang, Xiaoqin Ma, and Robin G. Qiu (2010), "The effect of standardization and customization on service satisfaction," *Journal of Service Science*, 2, 1-23.

Zahra, Shaker A., R. Duane Ireland, and Michael A. Hitt (2000), "International expansion by new venture firms: International diversity, mode of market entry, technological learning, and performance," *Academy of Management Journal*, 43(5), 925-950.

Zott, Christoph, Raphael Amit, and Lorenzo Massa (2011), "The business model: Recent developments and future research," *Journal of Management*, 37(4), 1019-1042.

Table 1. Means and correlations

Variable	Mean	SD	1	2	3	4	5	6	7	8	9	10	11
Customer interaction (1)	5.44	1.06											
Goods innovation performance (2)	4.77	.98	.32***										
Service innovation performance (3)	4.72	1.37	.33***	.39***									
Vendor customer knowledge mobilization resources (4)	5.11	1.04	.40***	.46***	.36***								
Service dependency (5)	40.02	32.30	.15	-.02	.32***	.06							
Technical product modularity (6)	4.67	1.32	.27**	.37***	.37***	.46***	.20*						
Service customization (7)	5.40	1.39	.24**	.06	.37***	.28**	.34***	.27**					
R&D intensity (8)	13.84	14.47	.09	.17	.13	.16	-.03	.28**	.01				
CRM intensity (9)	6.76	7.60	.22*	.22*	.13	.15	.04	.28**	.10	.53***			
Size [Employees] (10)	2.07	1.52	-.04	.11	.05	.09	-.01	.09	.16	-.17	-.03		
Size [Revenue] (11)	1.60	1.73	.02	.06	-.00	.16	-.17	-.06	.08	-.25**	-.11	.77***	
Export turnover (12)	23.42	27.32	-.13	.11	-.26**	-.06	-.36***	-.13	-.09	.00	-.16	.24**	.25**

*$p < .05$. **$p < .01$. ***$p < .001$.

Table 2. Results of hierarchical regression model

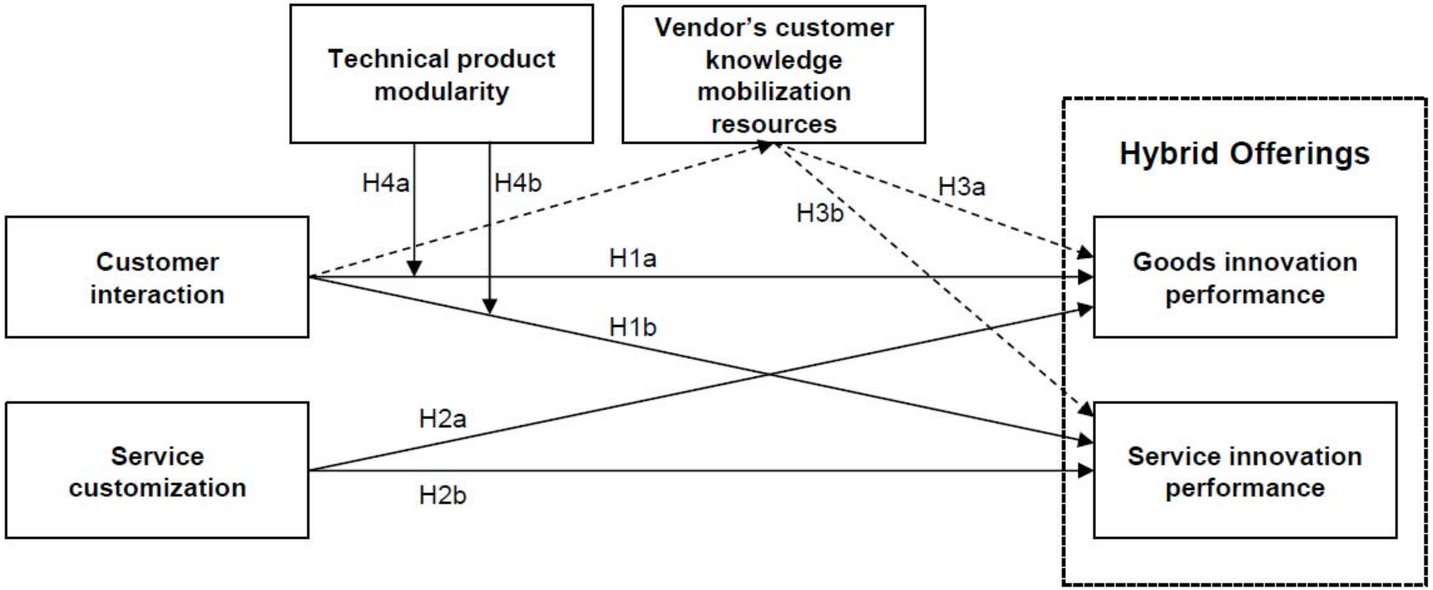
	Model 1 Goods innovation	Model 2 Goods innovation	Model 3 Goods innovation	Model 4 Service innovation	Model 5 Service innovation	Model 6 Service innovation
Controls						
R&D intensity	.00 (.00)	-.00 (.01)	-.00 (.01)	.02 (.01)	.01 (.01)	.01 (.01)
CRM intensity	.02 (.01)	.01 (.01)	.01 (.01)	.01 (.02)	-.01 (.02)	-.01 (.02)
Size [Employees]	.06 (.08)	.09 (.06)	.09 (.06)	.01 (.10)	.00 (.09)	.02 (.09)
Size [Revenue]	.02 (.07)	-.04 (.06)	-.04 (.06)	.07 (.10)	.01 (.09)	.01 (.09)
Industry	.20 (.20)	.19 (.18)	.21 (.18)	-.26 (.28)	-.33 (.25)	-.25 (.25)
Austria	.45 (.36)	.44 (.32)	.43 (.31)	.11 (.49)	-.13 (.45)	-.14 (.43)
Switzerland	1.08 (.98)	.33 (.88)	.29 (.88)	1.17 (1.53)	.77 (1.23)	.58 (1.20)
Share of revenue from service	-.00 (.00)	-.00 (.00)	-.00 (.00)	.02 (.00)***	.01 (.00)*	.01 (.00)*
Independent variables						
Customer interaction°		.16 (.08)*	.19 (.09)*		.23 (.11)*	.34 (.12)**
Service customization°		-.15 (.08)ˣ	-.16 (.08)*		.26 (.11)*	.24 (.11)*
Technical modularity°		.15 (.09)ˣ	.16 (.09)		.21 (.12)ˣ	.27 (.13)*
Technical modularity squared°		-.10 (.08)	-.11 (.09)		-.13 (.11)	-.20 (.12)
Interaction variables						
Customer interaction × Technical product modularity			.00 (.08)			-.04 (.12)
Customer interaction × Technical modularity squared			-.03 (.05)			-.18 (.07)*
Mediating variable						
Vendor's customer knowledge mobilization resources		.32 (.08)***	.32 (.08)***		.19 (.12)	.16 (.12)
Indirect effect [LLCI;ULCI]		.09 [.03;.17]	.10 [.04;.18]		.05 [-.01;.15]	.05 [-.02;.17]
R	.29	.57	.57	.34	.56	.60
R^2	.09	.32	.33	.12	.31	.36
ΔR^2		.23	.01		.19	.05
F	1.631	4.877	4.234	2.280	4.658	4.862
Number of observations	146	146	146	146	146	146

Note: Unstandardized coefficients, standard errors in parentheses.
°Mean centered variable.
ˣ$p < .1$. *$p < .05$. **$p < .01$. ***$p < .001$.

Table 3. Results of hypotheses testing

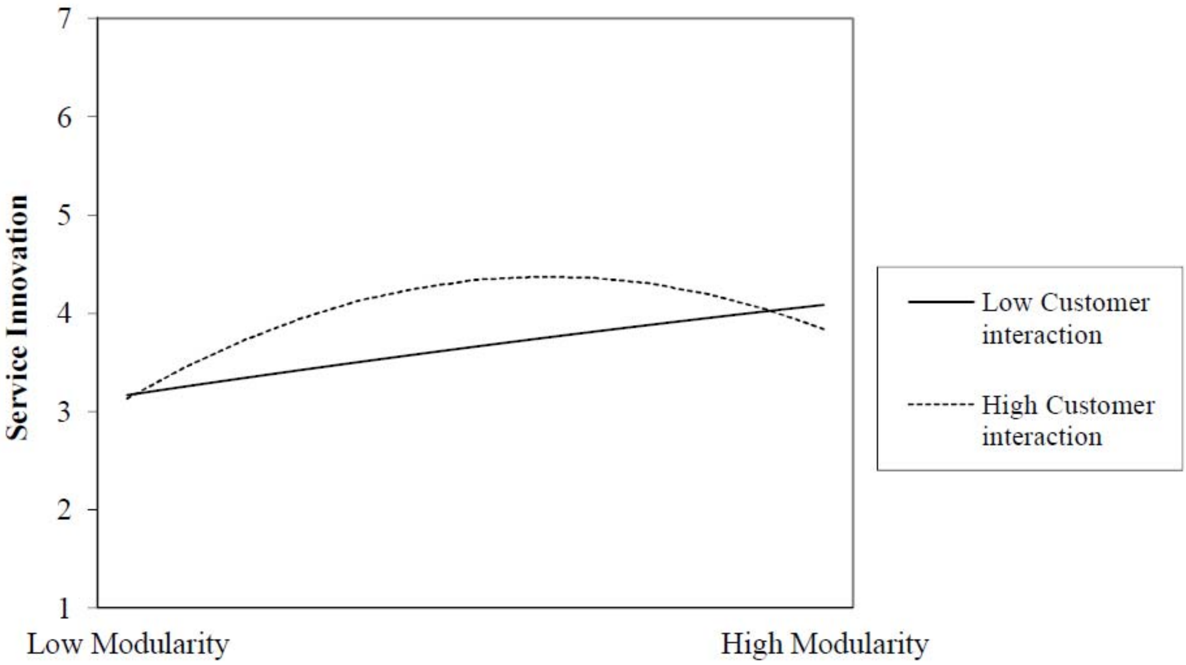
	Hypothesis	*supported*
H1a	*For hybrid offerings, customer interaction is positively associated with firms' goods-related innovation performance.*	*Yes*
H1b	*For hybrid offerings, customer interaction is positively associated with firms' service-related innovation performance.*	*Yes*
H2a	*For hybrid offerings, the degree of service customization is negatively associated with firms' goods-related innovation performance.*	*Yes*
H2b	*For hybrid offerings, the degree of service customization is positively associated with firms' service-related innovation performance.*	*Yes*
H3a	*For hybrid offerings, firms' customer knowledge mobilization resources mediate the direct relationship between customer interaction and goods-related innovation performance.*	*Yes*
H3b	*For hybrid offerings, firms' customer knowledge mobilization resources do not mediate the direct relationship between customer interaction and service-related innovation performance.*	*Yes*
H4a	*For hybrid offerings, the relationship between customer interaction and firms' goods-related innovation performance is strongest under intermediate levels of technical modularity, but comparatively weaker when technical modularity is low or high.*	*No*
H4b	*For hybrid offerings, the relationship between customer interaction and firms' service-related innovation performance is strongest under intermediate levels of technical modularity, but comparatively weaker when technical modularity is low or high.*	*Yes*

Figure 1. Conceptual Model



Note: Dotted lines pertain to the mediation hypotheses.

Figure 2


7
6
5
4
3
2
1
Service Innovation
Low Modularity
High Modularity
Low Customer interaction
High Customer interaction

Appendix

	Factor Loadings (CFA)	CA / CR	AVE
Customer interaction (adapted from Foss et al. 2011)		.76/.83	.63
To what extent are customers involved in close collaboration?	.541		
To what extent do you maintain intense communication with customers?	.873		
To what extent does the overall strategy of the firm emphasize close collaboration with customers?	.904		
Technical product modularity (adapted from Ghosh et al. 2006)		.70/.82	.61
The configuration of our core products is based on standard interfaces.	.815		
The composition of our core products is perfectly modular.	.923		
The composition of our core products can be chosen without taking into account other aspects (e.g., components, design, standards) of the product.	.549		
Vendor's customer knowledge mobilization resources (adapted from Ghosh et al. 2006)		.75/.84	.57
We have companywide systems to involve the customer in understanding the technological capabilities of our company.	.774		
We have cross-functional teams to enable the translation of customer needs into product features.	.686		
We have set up a knowledge system to transfer our experience from one customer context to another.	.771		
We have instituted policies to permit adaptation of our product configuration to customer needs.	.784		
Goods innovation performance (adapted from Song et al. 2006)		.75/.85	.60
The overall performance of our new goods development program has met our objectives.	.824		
From an overall profitability standpoint, our new goods development program has been successful.	.844		
Compared with our major competitors, our overall new goods development program is far more successful.	.814		
Compared to our major competitors, our new goods development cycle time has been relatively less.	.576		
Service innovation performance (adapted from Storey and Kahn 2010)		.88/.93	.81
This firm's new service development program is highly innovative.	.888		
This firm is successful at generating innovative new service ideas.	.951		
This firm' service offerings are perceived by its customers to be innovative.	.858		

Notes: N = 146. Standardized factor loadings; all factor loadings are significant at $p < .01$. CFA = confirmatory factor analysis; CA = Cronbach's alpha; CR = composite reliability; AVE = average variance extracted.