

**The Impact of Customer Involvement on New Product Development: Contingent and Substitutive Effects**

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## Abstract

More and more companies are actively involving their customers in the new product development (NPD) process. However, there is little consensus regarding the contribution of customer involvement to new product outcomes. A better understanding of this contribution can shed light on whether and when it is worthwhile to involve customers and thus provide firms better guidelines for making such decisions. This study examines the effects of two forms of customer involvement on new product outcomes: the traditional form of customer involvement as an information source (CIS) and the more active form of customer involvement as co-developers (CIC). The authors offer a better understanding of whether customer involvement can lead to successful innovation by (1) identifying conditions that impact the effects of CIS and CIC on NPD outcomes, (2) contrasting the conditional effects of CIS and CIC to understand how they influence NPD outcomes differently, (3) examining the potential substitutive relationship between CIS and CIC to understand their joint effects in improving innovation. They find that an experimental NPD approach that emphasizes trial and error learning moderates the relationship between customer involvement and new product outcomes. Specifically, the results reveal contrasting contingent effects of CIS and CIC: CIS is more beneficial for new product outcomes when firms take a more experimental NPD approach, whereas the effect of CIC is stronger when the NPD process is characterized with lower experimentation. CIS and CIC also substitute for each other in their contribution to new product outcomes. These findings suggest that each of the two forms of customer involvement has its unique advantages and is suitable for different conditions. When considering the adoption of CIC, firms should take into consideration their learning approaches as well as the effectiveness of CIS in the NPD process.

### Practitioner Points:

- When involving customers as co-developers, frequent experimentation in the NPD process may compromise new product outcomes.
- When involving customers as co-developers, firms may manage the challenges by limiting the amount of experimentation in the NPD process.
- When customers only play the role of an information source in the NPD process, frequent experimentation can help improve new product outcomes.

Keywords: customer involvement, co-development, experimentation, trial and error learning, innovation, new product development

## Introduction

An increasing number of companies are allowing customers to be actively involved in the new product development (NPD) process (Fang, 2008; Nambisan, 2002). For example, Boeing develops new aircraft models with airline carriers by incorporating customer representatives in its NPD team (Condit, 1994; Enkel et al., 2005); Hilti, a leading European manufacturer of construction equipment, develops innovative construction tools by collaborating with customers (Churchill et al., 2009). In the consumer sector, companies (e.g. Unilever) also select knowledgeable customers to develop new products together with internal experts (Aitchison, 2009; Needham et al., 2010). Different from the traditional form of customer involvement where customers serve as an information source, this new approach allows customers to participate in the NPD process as co-developers and engage in joint problem-solving with internal employees to generate product solutions (Fang, 2008; Nambisan, 2002).

Despite the great enthusiasm among practitioners and researchers for this new form of customer involvement, there is little consensus regarding its contribution to new product outcomes (Alam, 2002; Kristensson et al., 2004). While some studies argue that more reliance on customer inputs can help generate creative ideas (Nishikawa et al., 2013), improve product variety (Al-Zu'bi and Tsinopoulos, 2012) and enhance product performance (Lau et al., 2010), others find that active customer involvement may not contribute to product success (Carbonell et al., 2009; Gruner and Homburg, 2000) or may even negatively impact product outcomes (Knudsen, 2007). Without a better understanding of the effects of customer involvement on product outcomes, it is unclear whether such efforts can lead to successful innovation. As more and more firms consider adopting this new approach, a closer examination of its effects is crucial (Di Benedetto, 2012; Gemser and Perks, 2015; Hoyer et al., 2010).

Specifically, a few gaps exist in the literature that limit our understanding of the contribution of customer involvement to product outcomes. First, the inconsistent findings suggest possible contingencies in the effects of customer involvement. However, with rare exceptions (Fang, 2008; Menguc et al., 2014), research has not fully explored the contingent effects to understand when customer involvement is beneficial. Accordingly, scholars are calling for a contingent perspective that identifies boundary conditions and offers a more complete understanding of when customer involvement leads to successful innovation (Gemser and Perks, 2015; Mahr et al., 2014).

Second, compared to the traditional approach of customer involvement as an information source (CIS), customer involvement as co-developers (CIC) offers benefits but also faces substantial challenges (Gemser and Perks, 2015; Mahr et al., 2014). Research has recognized various issues that can prevent firms from realizing the benefits of active customer involvement, such as enlarged development task (Brockhoff, 2003), possibilities of information overload (Hoyer et al., 2010), and increased complexity of NPD management (Nambisan, 2002). However, current research lacks theoretical development and empirical testing of conditions under which firms may overcome these challenges and realize the benefit of customer involvement (Fang, 2008; Hoyer et al., 2010). One such condition this study examines is a firm's learning approach in NPD, specifically, its reliance on experimentation (Ries, 2011; Thomke, 2003). Such learning approaches may influence how customers can be integrated to the knowledge management process in NPD and thus affect firms' ability to overcome the above challenges so as to effectively utilize customer information.

Lastly, few studies have contrasted the effects of CIC and CIS to understand when CIC is more effective than CIS. Since CIS is the traditional approach commonly used among firms, the decision of adopting CIC requires a consideration of CIS and its effectiveness. CIS

and CIC employ different mechanisms to use customer information, therefore they likely face different challenges and thus are influenced differently by certain conditions. Research needs to simultaneously examine CIS and CIC to understand their contrasting effects.

A simultaneous examination of CIC and CIS also suggests the need to understand their joint effects in improving new product outcomes. Since CIS and CIC share the same goal of utilizing customer information, their effects on NPD outcomes may substitute for each other. Such an understanding can help answer questions such as whether CIC replaces or enhances CIS, and it will shed further light on whether and when a firm should adopt CIC.

To address the above gaps in the literature, this study aims to offer a more complete understanding of the contribution of customer involvement to NPD outcomes. Taking a knowledge management perspective (Joshi and Sharma, 2004), it views CIS and CIC as two ways of utilizing customer information and characterizes their contrasting attributes that may create different challenges for NPD. Based on these distinctions, this study examines customer involvement in three ways: (1) identifying a firm's experimental learning approach as a condition that affects its ability to manage the challenges of CIS and CIC and thus influences their effects on NPD outcomes; (2) contrasting the conditional effects of CIS and CIC to understand how they work differently in influencing NPD outcomes; (3) examining the potential substitutive relationship between CIS and CIC to understand how they work together in improving NPD outcomes. Using primary data from multiple industries, the study discovers contrasting contingent effects for the two forms of customer involvement: CIS is more beneficial for new product outcomes when the firm engages in higher levels of experimentation, whereas the effect of CIC is stronger when experimentation is at lower levels. In other words, when a firm uses CIC, highly experimental learning in NPD may compromise product outcomes. CIS also substitute for the effect of CIC such that CIC has a positive effect on product outcomes when the level of CIS is low but its effect is not

significant when CIS is high. The findings suggest that each of the two forms of customer involvement has its unique advantages and is suitable for different conditions.

This study contributes to the literature by identifying a boundary condition that helps understand when active customer involvement can lead to successful innovation. The contingent effects suggest that the form of customer involvement needs to be aligned with a firm's learning approach and that misalignment can render customer involvement ineffective. Viewing NPD as a knowledge management process allows us to conceptualize the fundamental differences between CIS and CIC based upon their mechanisms of managing customer information, and to further demonstrate that a firm's approach of learning in NPD has an inherent impact on which form of customer involvement is more effective in utilizing customer inputs. Theoretically, this study shows that the knowledge management view is a promising lens to examine this new phenomenon of active customer involvement. Empirically, the contrasting and joint effects of CIS and CIC illustrates the tradeoffs between the two forms of customer involvement and highlights the need for future research to simultaneously examine different forms of customer involvement. The study also demonstrates the challenges of opening up innovation to the customers and further suggests that aligning their learning approaches with customer involvement is an important way for firms to manage these challenges. The findings provide implications on how to choose the right form of customer involvement as well as how to manage CIS and CIC to develop successful new products.

### **Two Forms of Customer Involvement**

Following the literature, this study characterizes two forms of customer involvement: customer involvement as an information source (CIS) and customer involvement as co-developers (CIC) (Fang, 2008; Jeppesen, 2005; Nambisan, 2002). In CIS, the NPD team gathers information on customers' needs and wants by listening to the customers, often

through marketing research methods such as interviews, focus groups, and market surveys (Griffin and Hauser, 1993). Customers play the role of information providers, sharing knowledge on what they need or want for a new product. The internal NPD team takes the responsibility of applying information gathered from customers to the NPD process and design products that meet customers' needs. The CIS approach requires that firms transfer need information from customers to the NPD team before such information can be applied to product development. As the traditional approach of utilizing customer information, CIS is widely used, although some firms may engage in CIS activities to a higher degree than others.

In CIC, customers take part in the NPD process and develop new products together with the internal NPD experts. NPD becomes a collaborative process where customers work as partners with NPD employees<sup>1</sup>. Customers closely and frequently interact with internal NPD experts over an extended period of time (Knudsen, 2007). They engage in joint problem-solving with the NPD team and directly contribute to product design. Customers are also involved in making various decisions together with NPD employees, for example, regarding design of product features, specification of product interface requirements, and establishment of development process priorities and metrics (Lengnick-Hall, 1996). In CIC, customers' contributions constitute a significant portion of the NPD efforts (Fang, 2008).

Although CIC may be seen as a higher degree of customer involvement than CIS, this study follows the literature (Blazevic and Lievens, 2008; Fang, 2008) to treat them as two forms of involvement with contrasting attributes. A firm can engage in both forms of customer involvement at the same time. For example, it may conduct marketing research to acquire customer information as well as involve some customers as co-developers in the NPD process. A firm's engagement in these two approaches may be of different degrees.

CIS and CIC differ from each other in a number of ways. First, the role of customers in CIS is *passive* in the sense that they only share information when being prompted and that

the content of information they share depends on what the firm looks for in its research (Nambisan, 2002). In contrast, customers play an *active* role in CIC. Acting as collaborators in the NPD process, they may take the initiative to share information that they deem as relevant but is not asked for by the firm (Nambisan, 2002). Second, the role of the firm is different. In CIS, the firm drives the NPD process because it determines what type of information is collected and takes the sole responsibility of applying customer information to product design. In CIC, the firm acts as a partner and engages in collaborative problem solving and decision making with customers. Third, in CIS the interaction between customers and NPD employees is *discrete* in the sense that customer communication is limited to one time inquiry through which the firm seeks certain information. Although the firm may interact with the customers more than once, the number of interactions is limited, and each communication occurs for a limited time. In CIC, however, customer interaction is *continuous* as it occurs over an extended period of time during which customers are able to communicate with NPD employees more constantly. Lastly, in CIS customers only provide information on what they *need*, whereas in CIC customers share information on *both needs and solutions* that may satisfy their needs (Lilien et al., 2002; Piller and Walcher, 2006).

These differences have important implications for the use of customer information in NPD. First, the amount and nature of customer information obtained in these two forms of customer involvement are different. Customer information in CIC is of larger amount, more in-depth and detailed than that in CIS. In CIC, continuous interaction with customers not only generates a large volume of information, but also provides opportunities to develop a more detailed understanding of customer need than in CIS where customer interaction is discrete in nature (Nambisan, 2002). Furthermore, due to the customers' passive role, information sharing in CIS tends to be strongly influenced by the firm (Nambisan, 2002), whereas in CIC there is a higher chance of discovering information beyond the firm's planned research scope.

Second, the amount of interdependence between NPD employees and the customers is different in CIS and CIC. In CIS, NPD employees and customers play distinct roles where customers are passive information providers and NPD employees are responsible for applying customer information to product design. But in CIC, NPD employees and customers are highly dependent on one another in the process of joint product development (Bstieler and Hemmert, 2010; Fang, 2008). This strong interdependence enables more effective knowledge sharing, but it also requires substantial coordination with participating customers.

Thus, CIS and CIC face distinct challenges in the NPD process. The key challenge for CIS is not being able to obtain sufficient customer information or to fully utilize customer information. Because NPD employees determine what type of customer information is gathered and how such information is interpreted and utilized, their dominating role may constrain the use of creative customer inputs. CIC overcomes this challenge by granting customers a more active role, but it introduces new challenges: The large amount of detailed customer information increases the difficulty of information processing (Hoyer et al., 2010); the need for customer coordination increases the complexity of NPD management, which may lead to miscommunication and conflicts that could potentially hurt the effective use of customer information (Nambisan, 2002). These challenges facing CIS and CIC may influence the degree to which they are able to translate customer inputs into successful new products.

### **Theory and Hypotheses**

From the knowledge management perspective, how the aforementioned differences may impact CIS and CIC's effectiveness in utilizing customer information depends on the firm's approach of learning in NPD. The NPD process is a process of learning about a new product and searching for the right product solution (Thomke, 2003). CIS and CIC include customers in this learning process in different ways. The firm's learning approach may be more or less supportive of the different ways of incorporating customers, that is, it may

influence how CIS and CIC can manage the aforementioned challenges and effectively transform customer information into successful products. This study examines an important learning mechanism in NPD -- experimentation (Ries, 2011; Thomke, 2003), specifically, how a firm's reliance on an experimental learning approach may moderate the effects of CIS and CIC on new product outcomes.

Further, given that both CIS and CIC utilize customer information in NPD, their impact on product outcomes are inherently related. The firm may not be able to utilize the customer information obtained from different sources through different processes. NPD employees may not be able to effectively implement different ways of managing customers at the same time. Thus the challenges facing CIS and CIC may be multiplied when the firm engage in both approaches, suggesting that CIS and CIC may interact with each other in influencing NPD outcomes. This study examines how CIS and CIC may impact NPD outcomes together through their joint effects.

Figure 1 presents the conceptual framework that consists of the contingent and joint effects of CIS and CIC on new product outcomes. Three different new product outcomes are considered: new product innovativeness, new product advantage, and new product financial performance. New product innovativeness is the degree of newness of a product compared to existing products (Moorman, 1995). New product advantage refers to the extent to which a product is superior to market alternatives, that is, it provides unique benefits, is of higher quality and performance, and thus better meets customers' needs (Montoya-Weiss and Calantone, 1994). While new product innovativeness is concerned with technical and marketing discontinuities, new product advantage refers to a product's superiority relative to other products in the marketplace (Kleinschmidt and Cooper, 1991). New product financial performance is a product's ultimate performance in the market in terms of its market share,

sales, and return on investment (Moorman, 1995). Including these three outcomes allows us to consider different aspects of innovation performance.

This section starts with an introduction of the experimental learning approach in NPD, then examines how such a learning approach may have differential moderating effects on CIS and CIC, before moving to the joint effect of CIS and CIC.

<< Insert Figure 1 here >>

#### *An experimental learning approach in NPD*

Trial-and-error experimentation is an important learning mechanism for organizations (Huber, 1991; Ries, 2011). Firms experiment with different strategic alternatives and learn from the outcomes of such experimentation. The process starts with the selection of one or more possible options; the selected options are tried out and the outcome informs the next round of experiments (Huber, 1991; Ries, 2011). Learning through experimentation has been examined in various contexts such as organizational routines (Rerup and Feldman, 2011), new venturing (Loch et al. 2008), innovation (Coviello and Joseph, 2012; Lynn et al., 1996) and corporate venturing (Garud and van de ven, 1992).

Experimentation is an important means of learning in NPD (Leonard-Barton, 1995; Ries, 2011; Thomke, 2003). To find the right product solution, the firm engages in a trial and error process that consists of cycles of generating and testing design alternatives. Guided by initial insights as to where a solution may lie, the firm develops one or more designs. The first designs may or may not include the best possible solution, but they are tried out and information is gathered to revise the solution under development. Through these iterative cycles, the firm gains valuable understanding of the product and technology, and makes progress toward finding the right product solution.

An experimental NPD approach is defined as the degree to which a firm relies on frequent trial and error experiments to learn about a new product and develop product

solutions. Firms may engage in experimentation to different degrees in their NPD process. Firms with a highly experimental approach use trial and error experimentation as the main strategy of learning (Lynn et al., 1996). They engage in a large number of and frequent iterations of experiments, and they are willing to start designing and testing product designs before obtaining a complete understanding of the product (Leonard-Barton, 1995; Ries, 2011; Thomke, 2001). Given the uncertainty associated with NPD, developing a thorough understanding of the product can be difficult and time consuming. Starting experimentation without a complete understanding of the product allows the firm to conduct more experiments. In this case, learning about the new product is achieved mainly through trial and error rather than analysis of available information and comprehensive planning (Ries, 2011; Thomke, 2001). On the other hand, a less experimental firm engages in fewer iterations of experiments and starts experimenting with alternative designs only after thorough understandings have been gained from analysis and more guideline is available as to what could be a possible solution. Firms with a low level of experimentation tend to value analysis and planning more and do not rely on trial and error as the main strategy of learning.

A highly experimental approach allows for broader exploration of product solutions. The more frequently a firm experiments, the more it is able to explore a diverse portfolio of options (Bourgeon, 2002; Leonard-Barton, 1995, p.114). The outcomes of experiments, particularly unsuccessful ones, may reveal unexpected possibilities and change the direction for the next round of experiment (Leonard-Barton, 1995, p.119). Broad exploration is conducive to creativity (Lynn et al., 1996), but it also increases the amount of uncertainty in the NPD process (Thomke, 2003). Unexpected outcomes of experimentation can lead to changes that cause NPD to deviate substantially from its starting point. Managers that rely on experimentation as the main learning strategy are also more willing to try different things and make changes to existing designs (Ries, 2011). Thus, a highly experimental NPD process is

less focused than one of low experimentation in the sense that it is open to multiple possibilities rather than guided by a single direction.

*The contingent effects of CIS and CIC on new product innovativeness*

Research finds that the development of innovative new products relies on diverse knowledge inputs because the combination of diverse perspectives can inspire novel insights (Cohen and Levinthal, 1990; De Luca and Atuahene-Gima, 2007). Customer information is considered a key source of NPD creativity because customer inputs bring in new perspectives that are likely to be different from those of NPD employees (Im and Workman, 2004). Various studies have pointed out that a key motivation for involving customers in NPD is to harness their creativity (Kristensson et al., 2004). Both CIS and CIC have the potential to enhance product innovativeness because they help access customer knowledge and improve the diversity of knowledge inputs in NPD.

However, to translate diverse customer knowledge into innovative new products is not a straightforward process. It requires integrating customer knowledge with the NPD team's internal knowledge and transforming diverse inputs into creative product designs (Mahr, et al., 2014; Tsai et al., 2012). Research suggests that the development of innovative products requires openness and flexibility in the NPD process that allow different perspectives to be understood and existing knowledge to be seen in a new light, as well as control and direction that ensure novel insights are effectively integrated and implemented to generate product solutions (Chiang and Hung, 2014; Song and Chen, 2014). The aforementioned challenges facing CIS and CIC increase the difficulty of understanding and utilizing customer knowledge to generate innovative products. The firm's learning approach can influence how CIS and CIC can manage these challenges so as to effectively use customer inputs to improve product innovativeness.

The key challenge facing CIS is how to fully understand and utilize customer inputs to generate innovative product designs. The limited influence of customers in CIS does not provide as many opportunities as in CIC to ensure that their creative inputs are understood and utilized in NPD. A highly experimental approach characterized with broad exploration can complement CIS by offering more opportunities for utilizing customer creativity.

First of all, customer information obtained in CIS is of smaller volume and less in-depth than in CIC. A highly experimental approach can help better realize the creative potential of such information because trying a large variety of product solutions can help reinterpret the meanings and implications of customer information and thus increase the chance of discovering novel ways of using such information (Nambisan, 2002). Research has found that the process of examining different product designs helps develop a better understanding of customer information and harness tacit knowledge that is crucial for developing creative products (Bogers and Horst, 2014; Mascitelli, 2000). Thus, highly experimental learning can augment information from the more constrained CIS approach and unleashing new insights to enhance product innovativeness. On the other hand, with a low level of experimentation, the less in-depth customer information combined with a lack of broad exploration may cause new customer information to be insufficiently processed. Customer information can be misunderstood or incorporated in NPD in a simplistic manner such that the firm answers to customers' specific requests without understanding their underlying meaning (Ulwick, 2002). Customers are found to lack the ability to imagine potential needs useful for highly innovative products (Christensen and Bower, 1996). Using customer information without sufficiently exploring its various meanings and implications runs the risk of being misled by customers' specific requests and foregoing opportunities for highly novel products (Ulwick, 2002; Menguc et al., 2014).

Furthermore, although customer inputs may bring in new perspectives, in CIS NPD employees are solely responsible for interpreting and combining such information with internal knowledge in the NPD process. Without customers' direct participation, the interpretation and utilization of customer information is likely to be strongly influenced by NPD employees' existing knowledge, which can create rigidities that limit the use of new customer information to generate creative product solutions (Leonard-Barton 1992; Atuahene-Gima, 2005). In this case, a highly experimental approach can ensure that NPD employees try different ways of interpreting and utilizing customer information, and it thus helps overcome the potential constraining influence of firm existing knowledge on the creative use of customer information (Leonard-Barton, 1995). On the other hand, when experimentation is low, the strong influence of NPD employees' existing knowledge is reinforced. Compared to a highly experimental approach, a NPD process with low experimentation is less open to change, which increases the likelihood that existing knowledge prevents NPD employees from finding novel meanings and uses of customer information, thus constraining the contribution of CIS to new product innovativeness.

Therefore:

H1. The positive effect of CIS on new product innovativeness is stronger when the firm adopts a more experimental NPD approach.

CIC accesses customers' diverse knowledge through close interaction and joint problem solving with customers. The process of joint problem-solving can generate collective creativity beyond the capabilities of customers or the NPD team alone (Bissola and Imperatori, 2011). However, such collective creativity relies on effective information sharing between NPD employees and customers so that their diverse knowledge can be combined to generate innovative ideas and solutions (Nambisan, 2002). The aforementioned challenges facing CIC -- the difficulty of processing the large amount of detailed customer information and the complexity of customer coordination -- can impact the effectiveness of information

sharing and decision making, which are necessary conditions for developing innovative products (Frishammar and Hörte, 2005; Mahr et al., 2014; Schultz et al., 2013). These challenges are multiplied when the firm uses a highly experimental NPD approach characterized with broad exploration and high uncertainty, whereas a low level of experimentation can help overcome these challenges and thus enhance the contribution of CIC to product innovativeness.

First of all, when the firm adopts a highly experimental approach, it is even more difficult to process and integrate the large amount of customer inputs in NPD. Frequent experimentation driven by a large variety of customer inputs can generate even more information that needs to be correctly understood in order to generate product solutions. The interpretation and evaluation of new information is not guided by a single direction but rather multiple possibilities. Without a clear direction, it is more difficult to judge the quality and usefulness of the large volume of information such as its reliability and fit with the project (Durmusoglu, 2013). Not knowing which information to rely on or not being able to reconcile conflicting information creates barriers for the integration of diverse knowledge and the utilization of such knowledge to generate creative product solutions. Research has found that overly broad search can increase the challenge of information processing and have a detrimental impact on product creativity (Laursen and Salter, 2006; Salge et al., 2013). Thus, although customer information is a source for creativity, when combined with frequent experimentation it may lead to information overload and generate confusion (Hoyer et al., 2010; Nambisan, 2002), which is found to impair product innovativeness (Gebert, 2010; Tsai et al., 2012). On the other hand, by limiting the number of experiments, a firm can avoid producing an overwhelming amount of information that is difficult to process. A more focused NPD process provides clearer directions that can guide the interpretation and evaluation of new information and avoid confusion. In other words, a low level of

experimentation complements the large amount of information in CIC and helps more effectively transform customer inputs to innovative products.

Furthermore, a highly experimental NPD approach further increases the difficulty of customer coordination in CIC. When customers are included in the experimentation process as co-developers, they participate in the interpretation of experiment outcomes, evaluation of alternatives, and decision making regarding modifications for the next round of experiments (Fang, 2008; Nambisan, 2002). When NPD involves frequent trial and errors, not only a large number of decisions need to be made quickly, but also the complexity of decision making is increased due to the openness to multiple alternatives. Moreover, in such a highly uncertain process, it is more difficult to define the boundaries of collaboration because the tasks, knowledge needed, and methods of working change frequently. Thus the joint decision making process is faced with ambiguity that increases the chances of conflicts, particularly considering the customers' goals may not be aligned with the firm (Bstieler and Hemmert, 2010). Research has shown that conflicts are detrimental to creativity because they create challenges for successful information exchange and lower the quality of decision making (De Clercq et al., 2011; Farh et al., 2010; Pearsall et al., 2008). Without successful information sharing and high-quality decision making, customers' diverse knowledge cannot be effectively integrated to realize collective creativity (Mahr et al., 2014). Thus a highly experimental NPD approach may constrain the degree to which CIC is able to use customer information to improve product innovativeness.

On the other hand, clearer directions in a less experimental approach can enhance customer collaboration, avoid conflicts (Song and Chen, 2014), and increase decision making clarity in the NPD process (Schultz et al., 2013), all of which facilitates the effective integration of diverse knowledge to create innovative products. Research has found that clear directions are necessary for the development of innovative products (Nambisan, 2002; Song

and Chen, 2014). For example, strategic planning can improve product innovativeness because it offers guidance in the NPD process (Song and Chen, 2014), and highly innovative NPD projects are often managed with less flexibility and more control than incremental projects (Holahan et al., 2013). Thus, a low level of experimentation can complement the openness in CIC so as to improve the effective utilization of customer inputs and ultimately enhance product innovativeness. Therefore:

H2. The positive effect of CIC on new product innovativeness is weaker when the firm adopts a more experimental NPD approach.

#### *The substitutive relationship between CIS and CIC*

Both CIS and CIC bring information about customers' needs and wants. Redundancy may exist between the two sources of information and thus reduce each approach's unique benefit. Furthermore, the information obtained through CIS and CIC may not be consistent. While inconsistent information may stimulate creative thinking, the inconsistency has to be resolved for such information to be effectively utilized. Yet resolving inconsistent customer information can be challenging, and it adds to the already difficult task of processing the large amount of customer information. Confusions may arise and inhibit the effective use of information (Gebert, 2010; Tsai et al., 2012). Customer in CIC may not agree with NPD employees with regard to the interpretation of CIS information, which can create conflicts that hinder the realization of customer creativity.

More specifically, when the firm engages in a higher level of CIC, the large amount of detailed customer information generated through co-development in combination with the active role of customers may dominate the NPD process and reduce the chance of CIS information being utilized. On the other hand, when the firm relies heavily on CIS, CIC activities may not get enough managerial attention or organizational support to be carried out properly. Research has found that NPD managers' willingness to commit to customer integration depends on the general norm and acceptance of such strategies within the firm

(Bartl et al., 2012). The strong reliance on CIS may be perceived as a signal that the management is not fully committed to CIC. Such inconsistent messages from the management can hurt creativity because they reduce the employees' willingness to take risks (Lee et al., 2004). NPD employees may be more inclined to rely on information gathered from the familiar CIS approach and less willing to allow CIC customers play an active role in the joint decision making process, which reduces the chance of customer creativity in CIC.

Therefore:

H3. The interaction between CIS and CIC has a negative effect on new product innovativeness.

#### *The impact on new product performance*

While new product innovativeness captures the degree of newness of a product, a newer product does not always perform better on the market (Calantone et al., 2006; Huang and Tsai, 2014). To understand how the contingent and joint effects may contribute to a new product's ultimate performance, this study further examines how such effects influence new product advantage and new product financial performance.

Research has found that new product innovativeness is an important source of new product advantage because original features and designs can enable the product to better satisfy customers' needs than competing offerings (Calantone et al., 2006; Im et al., 2013). New product innovativeness thus provides opportunities for differentiating products from competition (Kleinschmidt and Cooper, 1991). In addition, customers may also consider newness itself a signal of product benefits and derive value from merely seeing product innovativeness (Radford and Bloch, 2011). Thus, new product innovativeness is positively associated with new product advantage, and CIS and CIC can influence new product advantage through new product innovativeness.

Furthermore, new product advantage is found to be positively associated with new product financial performance because products that have a strong advantage over its

competitors are more likely to gain market demand and thus enjoy higher sales, market share and profit (Li and Calantone, 1998; Song and Parry, 1997). New product innovativeness can improve new product financial performance through new product advantage because when newness is translated into superior product designs it helps better meet customer needs and thus improve sales (Huang and Tsai, 2014). Therefore, there is a sequential influence among the new product outcomes such that new product innovativeness mediates the effects of CIS and CIC on new product advantage and new product financial performance (Figure 1).

Combining the above arguments and what is established in H1-H3, this study proposes that the hypothesized contingent and joint effects of CIS and CIC influences new product advantage and new product financial performance through new product innovativeness. That is, the moderating effects of experimental NPD approach will indirectly influence new product advantage and financial performance such that CIS (CIC) will also have a stronger (weaker) effect on new product advantage and financial performance when the firm uses a more experimental NPD approach. Similarly, with regard to the joint effect, the effect of CIC on new product advantage and financial performance will be lower when the level of CIS is high. These hypotheses will be tested by examining the mediated moderation effects.

H4a. New product innovativeness mediates the contingent effects of CIS and CIC on new product advantage and new product financial performance.

H4b. New product innovativeness mediates the joint effect of CIS and CIC on new product advantage and new product financial performance.

## **Method**

### *Data*

The sampling frame used to gather data is the member list of the Product Development and Management Association (PDMA). PDMA is North America's largest professional association on innovation and new product development. Its members are

managers that are active in new product development and management. This sampling frame has been used in previous studies (Barczak et al., 2008; Calantone and Di Benedetto, 2007). On behalf of the researchers, the PDMA headquarter sent the survey to its 2984 members through emails, including two reminders after the initial survey distribution. Survey incentives included a copy of the aggregated results and a monetary amount as incentives (lottery prizes ranging between 20 and 300 dollars for 37 randomly selected respondents, with an estimated chance of winning 10%-30%). 341 completed surveys were received, resulting in a response rate of 11.43%, which is consistent with previous studies that used PDMA members as a sampling frame (Barczak et al., 2008; Calantone and Di Benedetto, 2007). Responses by academic members and responses in consulting industries were excluded. These steps resulted in 264 responses. After taking out missing values, the final sample included 236 responses for analysis. T-tests showed no significant differences in the key variables from different waves of responses, suggesting that response bias is not a significant concern.

Firms in the final sample represented a variety of industries including manufacturing, consumer packaged goods, utilities, information technology and telecommunications, healthcare, and financial services<sup>2</sup>. Consistent with previous studies of PDMA members (Barczak et al., 2009), manufacturing industries constituted the largest number of responses (44.07%). Consumer as well as B-to-B products were included in the sample<sup>3</sup>. A sample of diverse industries enhances the generalizability of the study. The annual sales of firms in the sample ranged from below 10 million dollars to more than 5 billion dollars.

Respondents answered the survey questions with regard to a completed NPD project in which they were directly involved in the past three years. Consistent with the cross-functional nature of NPD, the respondents came from different primary functional areas, including marketing (27.6%), R&D (35.8%), project management (26.3%), manufacturing

and operations (2.6%), and other areas such as design (7.7%). Despite their diverse backgrounds, all respondents were directly involved in the NPD projects. Their knowledge on the issues asked in the survey averaged 5.7 on a scale from 1 to 7 (1=very limited; 7=very knowledgeable), suggesting that they are knowledgeable about the projects (Li and Calantone, 1998; Rindfleisch and Moorman, 2001). The respondents' titles in the companies included product manager, new product development manager, VP or director of product management or innovation, chief innovation officer, etc., which are representative of the PDMA membership. On average, the respondents had 10.5 years of experience in the firm and 15.2 years of experience in the industry.

### *Measures*

Existing measures of constructs were used whenever it was possible. Some new items were developed based on theoretical discussions in the literature. Preliminary research including interviews and pretests were conducted to help develop the questionnaire and ensure the quality of data collection. Specific measurement items are presented in the Appendix.

*CIS.* The measures for CIS assess the degree to which a firm uses customers as a key information source, actively and frequently transfers information from customers to the new product team, and uses such information in new product development. Some items from Fang (2008) were adapted to the context of this study. Other items were developed based upon discussions in Nambisan (2002) and Fang (2008).

*CIC.* The measures for CIC assess the degree to which customers are actively involved in product development activities as co-developers, frequently interact with new product team and provide inputs to product design, as well as the degree to which customers' involvement constitutes a significant portion of product development effort. The items were

adapted from Fang (2008) or developed based upon discussions in Nambisan (2002) and Fang (2008).

*Experimental NPD approach.* The measures for experimental NPD approach assess the degree to which a firm relies on frequent trial and error to find the right product solution, views the NPD process as cycles of experiments, learning and additional experiments, and engages in trial and error before developing a complete understanding of the market and technology. The measures were developed based upon discussions in Lynn et al. (1996) and Thomke (2001).

*New product advantage.* New product advantage is measured with the degree to which a new product offers customers unique attributes that competing products are unable to provide and how much it outperforms competing products by better meeting customer needs. The items were borrowed from Slotegraaf and Atuahene-Gima (2011).

*New product innovativeness.* The measures for product innovativeness assess the extent to which the new product is novel to the industry and offers new ideas. The measures were borrowed from Moorman (1995).

A confirmatory factor analysis (CFA) was conducted to evaluate the quality of measures. The fit indices for the CFA indicated a good overall fit of the measurement model: comparative fit index (CFI) 0.940, standardized root mean square error (SRMR) 0.048, and root mean square error of approximation (RMSEA) 0.053. Specific factor loadings and t tests are presented in the Appendix. All item-construct loadings were high ( $\lambda > 0.62$ ) and significant ( $t > 10.25$ ), and the average variance explained for the constructs was above 0.5 (0.58 - 0.77), providing evidence for strong convergent validity. To assess discriminant validity, pairs of constructs were examined in a series of two-factor CFA analyses. Each two-factor CFA model was run twice, once constraining the correlation between the two constructs to one, and once with the correlation free. A chi-square difference test was

conducted to compare the two models. Significant chi-square results across all pairwise CFA analyses indicated sufficient discriminant validity between constructs. Furthermore, the average variance explained for the constructs were above the shared variance among constructs, providing further support for discriminant validity. The composite reliability for the constructs ranged between 0.80 and 0.93, indicating strong reliability of the measures.

A number of tests were conducted to assess potential common method bias. First, a Harmon's one-factor test showed that the one-factor model produced a significantly worse fit, providing preliminary support that common method bias is not a serious threat to measurement validity. Further, a structural equation modeling (SEM) approach was used to assess the potential influence of common method variance on data analysis (Lindell and Whitney, 2001; Podsakoff et al., 2003). Due to the complexity of interaction terms, a main-effect-only model was used for this purpose. The main-effect-only model included CIS, CIC and experimental approach as antecedents and the same dependent variables as in Figure 1. Following Lindell and Whitney (2001)'s approach, technological uncertainty was used to identify a common method factor because technological uncertainty is not correlated with the dependent variables in the data. A model in which the indicators of all constructs were loaded on the common method factor was compared with a model without the common method factor. Including common method factors did not significantly improve model fit ( $\Delta\chi^2=47.21$ ,  $\Delta df=50$ ), and the significance of coefficient estimates stayed the same, indicating that common method variance does not bias the relationships among constructs (Lindell and Whitney, 2001; Podsakoff et al., 2003).

<< Insert Table 1 here >>

### *Control variables*

Several factors that may influence the outcome variables were included as control variables. First, with regard to firm characteristics, firm R&D intensity was controlled for

because it is indicative of a firm's ability to generate better new products (Ahuja and Katila, 2001), so was firm size since large firms may have more resources for innovation (Chandy and Tellis, 2000). Furthermore, the diversity of customer needs was considered because when customers' needs are diverse, it is more difficult for the firm to understand the need of overall target market, which increases the challenge of developing successful new products (von Hippel and Katz, 2002). With regard to the environment, market and technological uncertainty may increase the difficulty of NPD and was thus included as control variables (De Luca and Atuahene-Gima, 2007). Dummy variables were also included to indicate business-to-consumer context and whether the project is developing a service rather than a tangible product, in addition to the specific industry of the firm (only significant industry dummies are included; results are not reported). Among the control variables, customer need diversity, market uncertainty and technological uncertainty are latent constructs and were thus included in the CFA model. Their measurement items and factor loadings are shown in Appendix A.

## **Results**

SEM was used to test the model. Although the incorporation of interaction effects in SEM has been challenging in the past (Kenney and Judd, 1984; Ping, 1995), recent advancements in this area have provided a unique approach that is based on the analysis of the multivariate distribution of the joint indicator vector and takes into account the nonnormal distribution of interaction variables (Klein and Moosbrugger, 2000). Known as the Latent Moderated Structural Equations (LMS) approach, this technique is readily implemented in Mplus (Muthén and Muthén, 2012). Adopting this approach allows us to estimate a SEM model with interaction effects while at the same time considering measurement errors of the latent constructs<sup>4</sup>. Modeling moderation effects as continuous interactions also enables us to conduct a mediated moderation analysis to assess the mediation effects of new product

innovativeness hypothesized in H4 (Hayes, 2013; Zhao et al., 2010). Since this new estimation approach does not produce the traditional fit indices, model fit was evaluated with a main-effect-only model that included CIS, CIC and experimental approach as antecedents and the same dependent variables as in Figure 1. This model produced good overall fit: CFI=0.925; RMSEA=0.057; SRMR=0.072.

Next the hypothesized interaction effects were added in the SEM model. To reduce the chance of higher order simple effects being mistaken for interaction effects, models including quadratic simple effects for CIS and CIC were examined. The quadratic effects were not significant and the interaction effects remained the same. Thus the quadratic terms were omitted to maintain a more parsimonious model. The model testing results are presented in Table 2.

<< Insert Table 2 here >>

H1 predicted that experimental NPD approach positively moderates the effect of CIS on new product innovativeness. A positive and significant interaction effect provided support for H1 ( $\beta=0.26$ ,  $p<0.01$ ). H2 indicated that experimental NPD approach negatively moderates the effect of CIC on new product innovativeness, and it was supported by a significant negative interaction effect ( $\beta= -0.13$ ,  $p<0.01$ ). H3 proposed a substitutive relationship between CIS and CIC. The interaction between CIS and CIC showed a significant negative effect on new product innovativeness ( $\beta=-0.10$ ,  $p=0.05$ ), thus providing support for H3.

To test H4, a mediation analysis was conducted following the latest procedure recommended by Zhao et al. (2010). This procedure focuses on explicit testing of indirect effects and relies on a significant indirect effect to confirm the presence of mediation. This procedure also recommends the use of a bootstrapping approach to test the indirect effects because it avoids the biases of the traditional Sobel test (Preacher and Hayes, 2004; Zhao et al., 2010). Following this recommendation, a bootstrapping procedure in Mplus was used to

test the indirect effects in the SEM model. First, the indirect effects of the hypothesized interactions on new product advantage were examined. All the indirect effects were significant: The interaction between CIS and experimental approach had a significant positive indirect effect on new product advantage ( $a \times b = 0.13$ ,  $SE = 0.03$ ; 95% confidence interval [CI] = 0.07, 0.20); the interaction between CIC and experimental approach had a significant negative indirect effect on new product advantage ( $a \times b = -0.06$ ,  $SE = 0.02$ ; 95% CI = -0.12, -0.03); the interaction between CIS and CIC had a significant negative indirect effect on new product advantage ( $a \times b = -0.05$ ,  $SE = 0.03$ ; 95% CI = -0.11, -0.002). To understand how the hypothesized effects ultimately contribute to new product financial performance, their indirect effects on new product financial performance were then examined. The interaction between CIS and experimental approach had a significant positive indirect effect on new product financial performance ( $a \times b \times c = 0.06$ ,  $SE = 0.02$ ; 95% CI = 0.03, 0.11); the interaction between CIC and experimental approach had a significant negative indirect effect on new product financial performance ( $a \times b \times c = -0.03$ ,  $SE = 0.01$ ; 95% CI = -0.06, -0.01); the interaction between CIS and CIC had a significant negative indirect effect on new product financial performance ( $a \times b \times c = -0.02$ ,  $SE = 0.01$ ; 95% CI = -0.06, -0.001). These significant indirect effects confirm that new product innovativeness mediates the contingent and joint effects of CIS and CIC on new product advantage and new product financial performance, thus providing support for H4a and H4b<sup>5</sup>.

Following Zhao et al.'s (2010) recommendation, the significance of direct effects was examined to determine the type of mediation, i.e., full or partial mediation. Among the hypothesized interaction terms, only the interaction between CIS and experimental NPD approach had significant direct effects on new product advantage ( $\beta = 0.14$ ,  $p < 0.01$ ) and on new product financial performance ( $\beta = 0.13$ ,  $p = 0.02$ ). Thus the interaction effect between CIS and experimental NPD approach is partially mediated by new product innovativeness,

but the interaction effect between CIC and experimental NPD approach and the interaction effect between CIS and CIC are fully mediated by new product innovativeness. In addition, new product innovativeness did not show a significant direct effect on new product financial performance, indicating that its effect on new product financial performance is fully mediated by new product advantage. This is consistent with existing findings that innovativeness of a new product can only contribute to product performance when it leads to improved product advantage and increased value to the customers (e.g., Huang and Tsai, 2014).

To further understand the interaction effects, we conducted a simple slope analysis (Figure 2 and 3) (Aiken and West, 1991). The graphs show that the effects of CIS and CIC vary substantially when a high or low level of experimental approach (one standard deviation above and below the mean) is used. Specifically, when experimental approach is high, CIS has a significant positive effect on product innovativeness ( $\beta = 0.65$ ,  $p < 0.01$ ), but its effect is not significant when experimental approach is low ( $\beta = -0.19$ ,  $p = 0.16$ ). On the contrary, CIC shows a significant positive effect on product innovativeness when experimental approach is low ( $\beta = 0.33$ ,  $p < 0.01$ ), but its effect is not significant when experimental approach is high ( $\beta = -0.09$ ,  $p = 0.40$ ). Further, the effect of CIC is positive and significant when CIS is low ( $\beta = 0.25$ ,  $p = 0.02$ ), but not significant when CIS is high ( $\beta = -0.01$ ,  $p = 0.93$ ), indicating substitution effects between CIS and CIC. Further simple slope analysis of the indirect effects of CIS and CIC on new product advantage and financial performance produced results that are highly consistent with those on new product innovativeness. A split sample analysis also showed highly consistent results: For firms with a low level of experimentation, CIC has a significant positive effect, but the effect of CIS is not significant; for firms with a high level of experimentation, CIS has a significant positive effect, but the effect of CIC is not significant. In both cases, a t test supports a significant difference between the effects of CIS and CIC. These findings indicate that CIS is more effective than CIC when a firm engages in highly

experimental learning, whereas CIC is more effective than CIS when NPD is characterized with low experimentation.

<< Insert Figure 2 and Figure 3 here >>

## **Discussion**

### *Discussion of results*

This study aims to better understand the contribution of two forms of customer involvement – CIS and CIC – to new product outcomes by examining their contingent effects and joint effects. With regard to the contingent effects, it finds that a firm's experimental learning approach moderates the effects of CIS and CIC in different ways: CIS is more beneficial for new product outcomes when the firm engages in higher levels of experimentation, whereas the effect of CIC is stronger when the NPD process is characterized with lower experimentation. The contrasting effects rest on the distinct knowledge management mechanisms of CIS and CIC and the different challenges they face. The key challenge facing CIS is not being able to obtain sufficient customer information or to fully utilize customer information to generate creative product designs, whereas the key challenge for CIC is the difficulty of processing a large amount of customer information and effectively coordinating with the customers. A firm's learning approach determines how it manages knowledge during the NPD process and thus influences the firm's ability to overcome these challenges so as to effectively utilize customer information. Highly experimental learning augments information from the more constrained CIS approach and unleashes new insights for innovation, whereas lower levels of experimentation constrain insights from CIS and limit the contribution of CIS to product outcomes. For CIC, higher levels of experimentation increase the difficulty of information processing and customer coordination and cause confusion and conflicts that may impair the effective use of customer information, whereas low experimentation helps maintain focus and direction, avoid confusion and conflicts, and

thus more effectively transform customer inputs into innovative and advantageous product designs. The findings suggest that CIS and CIC can only improve NPD outcomes if the firm's learning process is able to accommodate the challenges of involving customers.

Furthermore, the study finds support for a substitutive relationship between CIS and CIC. When CIS is low, CIC has a significant positive impact on new product outcomes, but when CIS is high, its effect is not significant. Similarly, strong effort in CIC can reduce the degree to which information from CIS improves new product outcomes. This finding indicates that engaging in large effort in both CIS and CIC will not generate double payoffs, but rather it reduces each approach's individual benefits. As two important means of utilizing customer information, CIS and CIC may face redundancy and conflicts that limit their joint contribution to innovation performance.

In addition, product innovativeness mediates the contingent effects and joint effects of CIS and CIC on new product advantage and new product financial performance. The contingent and substitutive relationships identified in this study not only impact product innovativeness but also translate to a new product's ultimate performance on the market. The mediation effect of product innovativeness also suggests that creativity plays an essential role in translating customer information into successful new products. This confirms previous understandings that customer information is a key source of creativity, and it suggests that a key aspect of managing customer involvement should focus on enhancing creativity through the integration of customer inputs.

#### *Theoretical implications*

First of all, this study identifies a boundary condition that influences the contribution of customer involvement to new product outcomes. It answers the call in recent literature for a better understanding of the conditions in which customer involvement leads to successful innovation (Gemser and Perks, 2015; Mahr et al., 2014). The contingent effects suggest that

the form of customer involvement needs to be aligned with a firm's learning approach and that misalignment can render customer involvement ineffective. Given the great enthusiasm toward active customer involvement and the lack of consensus on its actual contribution to NPD outcomes, this study offer a deeper understanding of the roles of CIS and CIC in innovation.

The moderating role of an experimental learning approach also suggests the need to consider firms' knowledge management processes when examining customer involvement. When customers are integrated into the NPD process, the way a firm manages learning has an inherent impact on how customer inputs can be utilized. Although traditional innovation research widely views NPD as a process of knowledge management, research on customer involvement has paid less attention to how customer involvement may challenge firms' learning processes and how the learning processes may influence the benefit of customer involvement. This study demonstrates that experimental learning may complement or inhibit the effectiveness of customer involvement in innovation. It shows that a knowledge management perspective can be useful for better understanding the effects of customer involvement as well as how to manage the process of involving customers.

From the perspective of open innovation, CIC can be seen as a more open form of innovation than CIS because it allows customers to have more influence in the NPD process. Our findings show that this open form of CIC may not be effective when the firm uses a highly experimental learning approach. The open innovation literature has a strong interest in understanding the right amount of openness and finds that exceedingly open processes are detrimental to innovation (Balka et al., 2014; Salge et al., 2013; West and Bogers, 2014). The contingent effects identified in this study contribute to this stream of literature by showing that the right amount of openness may depend on a firm's reliance on experimental learning.

Furthermore, different from existing literature that focuses on the benefits of customer involvement (Gemser and Perks, 2015; Mahr et al., 2014), this study examines the contribution of customer involvement to NPD with a consideration of its challenges. Although the literature has abundant descriptions of such challenges, there is a limited understanding of when firms are more able to manage them so as to improve innovation (Hoyer et al., 2010). This study demonstrates that in certain conditions these challenges may render customer involvement ineffective in improving product outcomes. The findings highlight the need to further examine the consequences of these challenges and the organizational capabilities needed to overcome them. Research on customer involvement can benefit from connecting with organizational research and traditional NPD research to better understand the organizational processes of involving customers.

Lastly, this study shows that contribution of CIC to NPD outcomes needs to be examined together with CIS. Taking a knowledge management perspective, it conceptualizes the fundamental differences between CIS and CIC and provides support for their contrasting effects. While the contingent effects suggest that CIS and CIC require different conditions to be effective, their joint effects suggest that they substitute for each other in improving NPD outcomes. Taking together, the findings indicate tradeoffs between CIS and CIC. A better understanding of such tradeoffs requires more research to simultaneously examine different approaches of customer involvement. Considering different approaches together not only allows for a more coherent conceptualization of the role of customers in innovation, but it can also help provide better guidelines on choosing the right approach of customer involvement.

#### *Managerial implications*

This study provides important implications for firms' decision making regarding customer involvement in NPD. The contrasting contingent effects suggest that when the firm's NPD approach is highly experimental, CIS is a preferable way of utilizing customer

information, whereas CIC is appropriate when the firm's reliance on experimentation is low. To make a more informed decision, firms would benefit from a clear assessment of the level of experimentation in its NPD process, for example, a better understanding of the number of trial and errors a project requires, the complexity of decision making in the process, and the flexibility of changing project directions. These would help the firm better judge the amount of added complexities when customers are involved as co-developers and the likelihood of successfully managing them.

The findings also shed light on how firms may better manage the challenges of CIS and CIC. When using a CIC approach, firms may mitigate its drawbacks by limiting the amount of experimentation in the NPD process. Reducing the number of experiments and using strategic planning to guide NPD can lower the complexity of information processing and joint decision making with customers. A firm may also better manage the co-development process by clearly defining the role of the customers and boundaries of collaboration, for example, specifying what types of decisions are made jointly with customers, what to do when disagreements arise, and how to resolve misunderstandings. When adopting the CIC approach, firms may start with projects that require less experimentation and have clear project guidelines before gradually advancing to more experimental projects. On the other hand, when carrying out CIS, firms would benefit from allowing more experimentation in the NPD process so as to fully utilize customer information. To support broad exploration, firms need to refrain from becoming overly invested in a certain product design and unwilling to make changes. Such escalation of commitment to product designs is common in NPD practice, and it needs to be overcome to support frequent trial and error learning (Schmidt and Calantone, 2002). It would be helpful to foster a culture of openness and risk-taking where the NPD team accepts failure as part of the learning process and is not overly judgmental on failed experiments (Thomke, 2001).

In addition, when considering adopting CIC, firms need to evaluate their CIS practice. Given the substantial challenges associated with CIC, it may not be worthwhile to use CIC when CIS is effective. Firms also need to manage CIS and CIC together in NPD. For example, CIS and CIC may generate inconsistent information, and firms need to make extra efforts to reconcile and integrate such information. CIS and CIC could also represent different cultures regarding customers' roles and their relationships with the firm. Using both approaches requires firms to carefully manage the different cultures within an organization. For example, to signal management's support for CIC, it may require a dial back on CIS effort.

#### *Limitations and future research*

One limitation of this study is that it only used survey-based measures to assess new product outcomes. Previous research has shown that perceived measures are closely related to actual product performance and have certain advantages (Calantone et al., 1996). For example, perceived measures are based on managers' assessment within their industries and cultures, and thus allow for comparison across firms (Calantone et al., 1996). Another limitation is that the study was not able to directly consider the individual characteristics of customers involved in NPD, for example, their knowledge and motivation. Although customer characteristics are important for issues such as customer selection, each innovation project faces customers with varying characteristics. Our focus is to examine the benefits of customer involvement for a NPD project, rather than what types of customers are suitable for involvement. In addition, other new product outcomes such as time to market and meeting cost constraints were not considered but may also be affected by customer involvement strategies. Future research could examine how CIS and CIC may contribute to these outcomes differently depending on the firm's experimental NPD approach.

This study highlights the need for future research to examine other contingent factors that will offer a more complete understanding of when customer involvement is able to

improve innovation performance. For example, a firm's organizational and strategic characteristics may influence its ability to manage customer involvement so as to realize its benefits. Environmental conditions such as market and technological uncertainty may affect whether involving customers introduces unmanageable ambiguity into NPD and ultimately harms innovation. Future research also needs to better assess the consequences of the challenges facing CIC and understand what organizational mechanisms are needed to overcome them. To do so, studies need to closely examine the specific processes of integrating customers (Bosch-Sijtsema and Bosch, 2015; Perks et al., 2012) and directly measure these challenges. Another interesting avenue of future research could be to examine the impact of CIC on existing NPD processes, for example, how the integration of customers may change NPD team dynamics and cross-functional collaborations.

**Footnotes:**

1. While the term co-creation is often used to broadly refer to any activities that utilize customers' creative inputs on product design, in this study customer involvement as co-developers only refers to situations where customers work closely with NPD employees to jointly develop new products. Therefore, practices such as idea competition or crowdsourcing (e.g., Poetz and Schreier, 2012) that gather new product ideas from customers but do not involve customers in developing these ideas are not considered CIC. Innovations developed solely by customers, such as user innovation with toolkits (e.g., von Hippel, 2001) or innovation in user communities (e.g., Füller et al., 2007), are also not considered CIC because customers do not work with NPD employees closely. For lead user methods, if advanced customers work with NPD employees to co-develop new products, they would be considered CIC.
2. A comparison (via t-tests) of the customer involvement constructs across industries showed no significant difference.
3. The concepts of CIS and CIC are based upon the role of customers and they apply to both B-to-B and B-to-C contexts. As an empirical verification, we tested for measurement equivalence between the B-to-B and B-to-C samples (Steenkamp and Baumgartner, 1998). A group analysis showed that no factor loading for the customer involvement constructs was significantly different across two samples. These results provide strong support for measurement equivalence across the two contexts, indicating that CIS and CIC are applicable to both B-to-B and B-to-C firms and they can be measured in the same way in these contexts. We also compared the means of the constructs across the two samples and found no significant difference. Thus we included both B-to-B and B-to-C cases in the final sample. We included a dummy variable B-to-C as a control variable in the analysis.
4. A common approach to testing moderation effects in SEM is multiple group analysis, but it requires the transformation of a continuous moderator into a dichotomous variable, which may cause bias in the analysis (Ping, 1995). The LMS approach is able to examine moderation effects with continuous interactions and at the same time consider measurement errors.
5. We also tested whether the main effects of CIS and CIC were mediated by new product innovativeness and found significance mediation effects. But our hypotheses focus on how the interaction effects in H1-H3 are mediated by new product innovativeness, as our goal is to show that the interaction effects can influence a product's ultimate performance.

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**Table 1. Means, standard deviations, and correlations**

	Mean	Standard deviation	Correlation											
			1	2	3	4	5	6	7	8	9	10	11	
1. CIS	5.45	1.27	1											
2. CIC	3.66	1.61	0.53**	1										
3. Experimental NPD approach	3.98	1.61	-0.04	0.15*	1									
4. New product innovativeness	4.88	1.29	0.18**	0.25**	0.06	1								
5. New product advantage	5.46	1.08	0.22**	0.24**	-0.04	0.54**	1							
6. New product financial performance	4.34	1.32	0.24**	0.30**	0.07	0.26**	0.42**	1						
7. Firm size	4.51	1.89	0.03	-0.06	-0.04	-0.05	-0.06	-0.01	1					
8. R&D intensity	2.51	1.18	0.06	0.08	0.02	0.02	0.02	-0.11	-0.11	1				
9. Customer need diversity	4.06	1.45	0.07	0.17**	0.10	0.05	0.02	0.002	-0.09	0.03	1			
10. Market uncertainty	4.15	1.36	0.01	0.06	0.10	-0.03	-0.05	0.03	-0.06	0.04	0.26**	1		
11. Technological uncertainty	4.44	1.50	0.08	0.09	-0.02	0.09	-0.02	-0.05	0.03	0.12*	0.23**	0.54**	1	

\* p&lt;0.05, \*\* p&lt;0.01

**Table 2. The effects of customer involvement on new product outcomes**

<i>Independent variables</i>	New product innovativeness		New product advantage		New product financial performance	
	<i>Coeff.</i>	<i>p value</i>	<i>Coeff.</i>	<i>p value</i>	<i>Coeff.</i>	<i>p value</i>
CIS	<b>0.23</b>	<b>0.04</b>				
CIC	<b>0.12</b>	<b>0.09</b>				
Experimental NPD approach	0.01	0.82				
CIS X Experimental NPD approach	<b>0.26</b>	<b>&lt;0.01</b>				
CIC X Experimental NPD approach	<b>-0.13</b>	<b>&lt;0.01</b>				
CIS X CIC	<b>-0.10</b>	<b>0.05</b>				
New product innovativeness			<b>0.49</b>	<b>&lt;0.01</b>		
New product advantage					<b>0.50</b>	<b>&lt;0.01</b>
<i>Control variables</i>						
Firm size	-0.05	0.22	-0.02	0.53	0.02	0.62
R&D intensity	-0.02	0.82	0.00	0.98	-0.09	0.13
Customer need diversity	0.02	0.73	0.02	0.63	0.02	0.78
B-to-C	0.15	0.48	<b>-0.42</b>	<b>0.01</b>	<b>0.37</b>	<b>0.07</b>
Service	0.22	0.26	-0.18	0.21	-0.23	0.19
Market uncertainty	-0.10	0.17	0.01	0.85	0.01	0.90
Technological uncertainty	0.08	0.19	-0.05	0.34	-0.05	0.39

1. Unstandardized coefficients are reported.

2. Bold numbers are significant results.

## Appendix: Measurement items

Constructs	Loading	t-value
<b>Customer involvement as information source (CIS)</b> (1=strongly disagree, 7= strongly agree) $\alpha=0.89$ , CR = 0.90, AVE =0.69		
During the new product development process:		
1. We used customers as a key information source.	0.78	13.97
2. We actively transferred information gathered from our customers to the development team.	0.88	16.99
3. The transfer of information about customers' needs and preferences took place frequently.	0.82	15.06
4. We used information about our customers' needs in the development of the new product.	0.83	15.38
<b>Customer as involvement co-developers (CIC)</b> (1=strongly disagree, 7= strongly agree) $\alpha=0.94$ , CR = 0.93, AVE=0.74		
During the new product development process:		
1. Our customers' involvement as co-developers of the product was significant.	0.81	15.24
2. Our customers were actively involved in a variety of product designs and development activities.	0.86	16.68
3. Our customers frequently interacted with the new product team during the development process.	0.90	17.82
4. Our customers provided frequent feedbacks and inputs on product designs.	0.90	18.03
5. Our customers' involvement constituted a significant portion of the overall product development effort.	0.83	15.85
<b>Experimental NPD approach</b> (1=strongly disagree, 7= strongly agree) $\alpha=0.89$ , CR = 0.89, AVE=0.68		
In new product development:		
1. We took an <u>experimental</u> approach that relied on frequent trial and error to find the right product solution.	0.90	17.57
2. We viewed new product development as cycles of experiments, learning, and additional experiments.	0.86	16.21
3. We engage in the trial and error process in product development before we had a complete understanding of the market and technology.	0.74	12.95
4. We tried many different product solutions before we found the right one.	0.78	14.09
<b>New product innovativeness</b> (7 point semantic differential scale) $\alpha=0.93$ , CR = 0.93, AVE=0.72		
Please rate the degree to which this new product was:	0.80	14.91
1. Very novel for your industry.		
2. Challenging existing ideas in your industry.	0.82	15.48
3. Offering new ideas to your industry.	0.90	17.74
4. Highly creative.	0.87	16.88
5. Very interesting.	0.86	16.50
<b>New product advantage</b> (1=strongly disagree, 7= strongly agree) $\alpha=0.90$ , CR = 0.90, AVE =0.69		
The new product developed from this project:	0.82	15.18
1. Was of higher quality than competing products.		
2. Was superior to competing products in terms of meeting customers' needs.	0.92	18.34
3. Offered unique benefits to the customers.	0.82	15.15
4. Performed better than competitors' products.	0.76	13.67
<b>New product financial performance</b> (7 point semantic differential scale 1 to 7, 1-far low, 7-far above), $\alpha=0.92$ , CR=0.91, AVE=0.77		
Generally speaking, to what extent did this new product achieve the following outcomes during the first year of its life in the marketplace?		
1. Return on investment relative to its stated objective	0.83	15.48
2. Sales relative to its stated objective	0.96	19.58
3. Market share relative to its stated objective	0.83	15.65
<b>Firm size</b>	-----	-----
Approximately, what are the total annual sales of your company in 2011 or the most recent fiscal year?		
<input type="checkbox"/> <10 million <input type="checkbox"/> 10-49 million <input type="checkbox"/> 50-99 million <input type="checkbox"/> 100-499 million <input type="checkbox"/> 500-999 million <input type="checkbox"/> 1-5 billion <input type="checkbox"/> > 5 billion		
<b>R&amp;D intensity</b>		
Approximately, what is your company's approximate R&D expenditure-to-sales ratio in 2011 or the most recent fiscal year?		
<input type="checkbox"/> < 1% <input type="checkbox"/> 1-5% <input type="checkbox"/> 6-10% <input type="checkbox"/> 11-15% <input type="checkbox"/> 16-20% <input type="checkbox"/> 21-25% <input type="checkbox"/> > 25%	-----	-----
<b>Customer need diversity</b> (1=strongly disagree, 7= strongly agree) $\alpha=0.81$ , CR = 0.80, AVE =0.58		
Please rate the degree to which you agree or disagree with the following statements.		
Our customer needs for this project were very diverse.	0.75	12.14
Our customer needs could not be fully satisfied with a standardized design.	0.72	11.67
Our customers had expressed a widely varying set of preferences for the final product design.	0.81	13.28
<b>Market uncertainty</b> (1=strongly disagree, 7= strongly agree) $\alpha=0.86$ , CR = 0.85, AVE =0.60		
Please rate the degree to which you agree or disagree with the following statements.		
In our industry, customers tend to look for new products all the time.	0.73	12.73
Customers' product preferences change frequently over time	0.84	15.48
Market demand is constantly changing in our industry.	0.88	16.47
In our industry, new customers tend to have needs that are different from those of existing customers.	0.62	10.25
<b>Technological uncertainty</b> (1=strongly disagree, 7= strongly agree) $\alpha=0.88$ , CR = 0.88, AVE =0.71		
Please rate the degree to which you agree or disagree with the following statements.		
The technology in our industry is changing rapidly.	0.83	15.27
Technological changes provide substantial opportunities in our industry	0.86	15.93
A large number of new product ideas have been made possible through technological breakthroughs in our industry.	0.83	15.23

Note: CR - Composite reliability; AVE - Average variance explained