Paper to be presented at
the DRUID16 20th Anniversary Conference
Copenhagen, June 13-15, 2016

Supplier innovation and involvement in customer firms A matter of learning and exhaustion?

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Abstract

This paper analyses how involvement in customer firms relates to suppliers' own innovation activity, with a particular emphasis on involvement in customers' innovation activities. One the one hand, firms may gain learning benefits from being involved in their customers' innovation activities, leading to a positive relation between involvement and supplier firms' own product innovation activities. On the other hand, involvement in customers' innovation activities may exhausts suppliers' knowledge resources, leading to a negative relation between involvement and suppliers' own product innovation activities. This paper argues that learning and exhaustion effects are not necessarily mutually exclusive, but depend on the scope and timing of suppliers' involvement in their customers' innovation processes. The paper shows that it is not always beneficial for suppliers to be involved in their customers' innovation process. Therefore, becoming involved is an option that should be selectively pursued by suppliers. Early involvement is important, but not sufficient for suppliers to reap an innovation benefit from contributing to customers' innovation activities. Suppliers that are involved in all phases of their customers' innovation process are more likely to be innovative than other suppliers. The analyses is based on a combination of different data sources, resulting in a combined sample of 209 supplier firms in Denmark. Innovation activity is tracked through two consecutive Community Innovation Surveys, thus

allowing to control for suppliers' previous innovation activity in the analyses.

Jelcodes:O32,O31

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KEY WORDS: Customer-supplier relations; customer involvement; innovation.

JEL CODES: O31, O32, O33.

Introduction

Suppliers are often found to be an important contributor to innovation activities in customer firms (von Hippel, 1988; Brown & Eisenhardt, 1995; Brem & Tidd, 2012). This is supported by the European Community Innovation surveys, which generally rank suppliers as the second-most important external source of innovation after customers.[1] Given suppliers' importance for innovation, there is surprisingly little attention on suppliers' gains from participating in customers' innovation activities in the innovation literature. More specifically, almost all studies concern customers' innovation benefits from involving suppliers and very little is known about the impact on the suppliers' own innovation performance from being involved in their customers' innovation activities (Tranekjer & Knudsen, 2012; Jean et al., 2014).

Thus, there is a lack of knowledge on whether suppliers benefit from contributing to customers' innovation activities. This is important not only for innovation research, but also for suppliers' strategic considerations regarding customer involvement. Previous studies on suppliers' involvement in customers' innovation activities are primarily case or sector-specific studies (see e.g. Jean et al., 2014) or tend to treat involvement as a dichotomous decision leaving no room for discussing the extent of involvement. In contrast, the literature concerned with customers' innovation benefits (see for instance Clark, 1989; Eisenhardt & Tabrizi, 1995) illustrates the importance of focusing on the degree of involvement (scope) as well as the timing of involvement. Therefore, scope and timing may also be relevant issues to explore from the supplier side.

Two main strands of literature are related to the question of how suppliers' innovation performance may be affected by contributing to their customers' innovation activities. One strand of literature emphasizes learning benefits and other positive spill-over effects for suppliers' innovation activities from being involved

[1] The most recent survey finds that 79.6 % of the innovative firms have used information from their suppliers as a source of innovation, and 25.5 % of these firms considered suppliers to be highly important for their innovation process. Source: Eurostat Innovation Statistics 2012 accessed January 7, 2016: http://ec.europa.eu/eurostat/statistics-explained/index.php/Innovation_statistics.

in their customers' innovation activities (e.g., Appleyard, 2003; De Jong & Von Hippel, 2009). Another strand of literature sees suppliers' involvement in their customers' innovation activities as an exploitative or exhaustive process, which reduces rather than adds to the supplier's own innovation ability (e.g., Boisot, 1995; Möller & Törrönen, 2003; Helper & Sako, 2010).

The present paper addresses the question on how customer-involvement relates to the suppliers' own innovation activity, with a particular emphasis on involvement in customers' innovation activities. The paper contributes to the literature in the following ways: First, it takes the suppliers' perspective, which has been given less attention in the literature on collaborative innovation. Second, compared to the relatively few other studies available, this paper takes a broader, cross-industry approach to collaborative innovation. Third, the paper explores whether scope and timing of involvement in customers' innovation activities matters for the relation to the supplier firms' own product innovation activity.

The empirical analysis is based on a unique cross-industry data set, which focuses on the supplier perspective by mapping suppliers' relations to their most important customers. This data set is combined with innovation data from two consecutive Danish innovation surveys. The analysis focuses on suppliers' product innovation activities.

The paper is structured as follows: the next section outlines the theoretical background for studying supplier involvement in customers' innovation activities and develops hypotheses to be tested in the empirical part of the paper. The subsequent section describes the data and method, followed by the empirical analysis. The paper concludes with a discussion of results and implications.

Supplier involvement in customers' innovation

A large part of the innovation literature is concerned with external involvement. The phenomenon is discussed in relation to open innovation (e.g., West & Borgers, 2014), interfirm collaboration (e.g., Laursen & Salter, 2006), user-producer interaction (e.g., Lundvall, 1988; Freeman, 1991) and distributed innovation

(e.g., Sawhney & Prandelli, 2000). Although supplier involvement in customers' innovation activities can take many forms, most contributions relate to suppliers participating and even taking over sub-elements of development processes governed by their customers (Clark, 1989; Hillebrand & Wim, 2004; Yoo et al., 2015). In the present context, our focus is on product development activities as one form of innovation activity.

The discussion of suppliers' innovative gains from involvement in their customers' innovation activities ties in with a broader issue in the innovation literature concerning the collaborative or rival nature of inter-firm collaboration on innovation (Hamel, 1991; Ritala & Hurmelinna-Laukkanen, 2009). Therefore, in the following, suppliers' involvement in customer innovation is discussed first as a general issue of interfirm interaction and whether this is a mutually beneficial or imbalanced relation. Second, taking a process-oriented perspective on supplier involvement the discussion focuses on how scope and timing may influence the interaction between the two firms.

Inter-firm collaboration is often considered positive for innovation activities without necessarily considering the extent to which this applies for both parties involved (Laursen & Salter, 2006; von Hippel, 1988). The arguments behind this view are that discovery requires knowledge, openness, and interfirm reciprocity with respect to knowledge sharing (Van de Ven, 1986). Knowledge reciprocity relates to signaling openness and intentions of trust to business partners (Lawson & Lorenz, 1999; Meeus et al., 2001). Therefore, the ability for a supplier to gain access to and be "in the loop" of the innovation activities in a particular field hinges on its ability to provide innovative inputs that contribute to the overall development of knowledge (Powell et al., 1996). Others suggests that opening up and diffusing knowledge to customers, suppliers and even others may also lead to adoption effects as these actors commit to the firms' technology and actively engage in furthering it – hereby potentially increasing the suppliers' learning benefits (Boisot, 1995; Garud & Kamaraswarmy, 1993).

The literature on innovation search processes demonstrates that sources outside the firm contribute positively to the scope and scale of innovation output (see e.g., Laursen, 2012). Furthermore, it is assumed that access to value appropriation from a shared pool of innovation insights depends on reciprocity and distributive justice, suggesting positive returns from increased involvement (Franke et al., 2013). This leads to the following "learning hypothesis" regarding firms' involvement in their customers' innovation activities:

H1: Firms gain learning benefits from being involved in their customers' innovation activities, leading to a positive relation between involvement and supplier firms' own product innovation activities.

However, others suggest that being involved in customers' innovation activities may hamper suppliers' own innovation performance. One particular concern relates to the scarcity of resources that are critical for innovation activities. From a resource-based point of view, the ability for a supplier to participate in a customer's innovation activities hinges on control of critical human resources (Wright et al., 2001). The opportunities for deploying these resources are limited. Even though learning possibilities may arise, the possibilities for exploiting these opportunities in other contexts is restrained by the specific innovation context related to their customers' innovation activities (Möller & Törrönen, 2003). In addition, the literature on captive suppliers suggests that the power relations in the value chain expose suppliers to opportunistic behavior from their customers (Helper & Sako, 2010). This may restrain the suppliers' possibilities for benefitting from their involvement in customers' innovation processes. Secondly, if knowledge is assumed to be an informational asset, which has value for the beholder, because of its rarity, suppliers will, by diffusing their knowledge assets lose positional advantages in bargaining with their customers, which might reduce the suppliers' incentive to innovate (Boisot, 1995; Arrow, 1996). Therefore, the following "exhaustion hypothesis" expresses how the above strand of literature emphasizes that

suppliers' own innovation activities may be constrained by the resources committed to their customers' innovation activities:

H2: Involvement in customers' innovation activities exhausts suppliers' knowledge resources, leading to a negative relation between involvement and suppliers' own product innovation activities.

From a supplier perspective, the learning and exhaustion effects are not necessarily mutually exclusive, but may require some form of balancing efforts. For instance, a component supplier deeply involved in a customer's new product development activities may incur learning benefits while at the same time being challenged with respect to how and to what extent this knowledge is deployable in other customer relationships.

The literature on supplier involvement typically concerns managing supplier involvement from the customer firm's point of view. It shows that supplier involvement in customer innovation should be applied selectively (Ragatz et al., 2002; Eisenhardt & Tabrizi, 1995; Potter & Lawson, 2013). Firms are expected to weight the time and effort allocated to involving a supplier in a new product development task with the potential benefit of handing over development tasks in terms of saved man-hours and supplier resources mobilized, suggesting that supplier involvement is a way to replace the traditional pattern of the vertically integrated model for organization (Clark, 1989; Wynstra et al., 1999). Therefore, suppliers' involvement in their customers' innovation activities is contingent on both parties. Thus, the suppliers can have different roles and be involved to various degrees, which would affect the suppliers' potential benefits from involvement. This argument concerning the management of degree and scope of involvement as a core priority for suppliers is developed further below.

Innovation managers have different approaches for mediating supplier involvement, depending on the degree and scope of involvement (Wynstra et al., 2001; McIvor & Humphreys, 2004). Degree and scope refer to the types of new product development tasks in which suppliers are involved (Clark, 1989;

Eisenhardt & Tabrizi, 1995), the timing of supplier involvement (Bonaccorsi & Lipparini, 1994; McIvor & Humphreys, 2004; Petersen et al., 2005) and the degree of development responsibility held by the supplier (Wynstra et al., 2001). Seen from the suppliers' perspective, the degree of involvement is likely to influence whether learning or exhaustion effects on own innovation activity dominate. For instance, Jean et al. (2014) study suppliers to the Chinese automotive industry and find an inverse u-shaped relation between the involvement with customers in collaborative design and the suppliers' own product innovation performance. However, the design phase is only one of several product innovation phases where the suppliers can be involved. Being involved in several phases increases the suppliers' potential learning benefits, but it also increases the resource commitment to the customers' innovation activities. This implies that the relation between supplier involvement in customers' innovation activities and suppliers' own product innovation activities may be more complex than a question of being involved or not.

Seen from a customer perspective, early involvement of the supplier could specifically impact on the customers' innovation activities (Eisenhardt and Tabrizi, 1995), because early involvement improves possibilities for including suppliers' inputs in the concept development, rather than adjusting for them later on in the innovation process. Timing is therefore an issue that impacts on customer firms' innovation output. This point has been followed up by several researchers concerned with early supplier involvement in innovation (Wagner & Hogel, 2006). Likewise, it may be assumed that suppliers learn more from being involved in the early stages of their customers' innovation processes due to a more open exchange of ideas and knowledge than at later stages of development, where more design parameters are locked. The above considerations are combined in a "scope and timing" hypothesis:

H3: The scope and timing of firms' involvement in customers' innovation activities affects whether learning or exhaustion effects dominate the relation between involvement and supplier firms' own product innovation activities.

Other factors that are not directly related to involvement in customers' innovation activities are also likely to influence suppliers' innovation activities. First, the suppliers' general dependence on their customers can influence whether the learning or exhaustion effects dominate (Cox, 1999). The suppliers' dependence is influenced by several factors, such as the duration of the relationship with the customer, the importance of the customer in terms of sales, as well as the suppliers' position in the value chain and potential customization of products and services. The higher the dependence of a supplier on a single customer, the more power the customer has in the relation, which would increase the possibilities for exploitation and exhaustion to dominate (Wynstra et al., 2010). Second, the supplier firms' previous innovation activities and own investments in R&D are not only likely to increase the suppliers' internal capacity to innovate, but also increase the suppliers absorptive capacity (Cohen and Levinthal, 1990) and thus enhance the possibilities for achieving learning benefits from participating in their customers' innovation activities. Finally, the location of and distance to the customer may also have an impact on whether learning or exhaustion effects dominate the relation between firms and their most important customer due to the importance of localized learning (see e.g. Malmberg and Maskell, 2006). The subsequent analyses control for these factors.

Data and method

The empirical analyses are based on a combination of three datasets on Danish firms. The two first data sets are derived from the Danish version of the Community Innovation Survey referring to the periods 2008-2010 and 2011-2013 respectively. Participation in the innovation survey is mandatory and the data are derived from responses from 5,000 randomly selected firms from a population of 22,000 firms. The firms are selected based on their number of employees and industry affiliation. Industries with a high research and development intensity have broader coverage than less research and development intensive industries. The innovation surveys are carried out every year, and the samples are partly overlapping, making it possible to follow firms' innovation activity over time.

The third data source is a unique cross-industry data set on suppliers' relations to their most important customers referring to the same time period as the latest innovation survey data. This data set is based on a non-mandatory survey of the total population of approximately 4,000 firms with at least 10 employees in manufacturing industries as well as a few selected business services industries. 980 firms answered the questionnaire on suppliers' relations to their most important customers, resulting in a response rate of 23.4 percent. Combining the three data sets results in a matched sample of 209 firms. The subsequent analyses are based on these 209 firms, weighted on the basis of number of employees and industry affiliation.

As an initial step, in Model 1, it is explored whether supplier firms' previous product innovation performance matters for their likelihood of being involved in customer firms' innovation activities.[2] This step is taken in order to to check whether suppliers' past innovation performance has an influence on being involved in customer firms' development activities, thereby acknowledging that suppliers' innovation activities may not only be affected by involvement in customers, but that customers may also be biased towards seeking to involve already innovative suppliers. This model controls for turnover generated by the customer and the duration of relation, in-house R&D, number of employees, industry, and location of the customer.

Subsequently, the three hypotheses are tested through logistic regression analyses of the factors that influence the likelihood of supplier firms' introducing product innovations. The dependent variable is a binary variable expressing whether the supplier has introduced a new or improved product or service (i.e. product innovation) during the period 2011-13. The models control for supplier dependence on the customer, expressed by turnover, duration and whether the supplier is a sub-supplier, as well as in-house R&D, number of employees, industry, and the location of the customer.

[2] The innovation activities in the customer firms comprise of development activities without considering whether these activities result in actual innovations.

The learning and exhaustion views on the relation between involvement in customers' innovation activities and supplier firms' own product innovation activities are first explored from the point of view of involvement being a dichotomous decision. Model 2 tests whether learning (Hypothesis 1) or exhaustion (Hypothesis 2) effects dominate the relation between suppliers' involvement in their customers' innovation activities and the suppliers' own product innovation activities. Thus, the explanatory variable is binary, expressing whether the supplier firms have been involved in their most important customers' innovation activities or not.

However, discussing whether learning or exhaustion effects dominate from a dichotomous perspective, where it is a matter of being involved in customer development or not, may be too simplistic for capturing potential relations between involvement in customer development and firms' own innovation activity. Therefore, involvement in customer development is also analyzed as a process, where focus is on the timing and scope of involvement. Model 3 tests Hypothesis 3 stating that suppliers' involvement in customers' innovation activity should be perceived as a process rather than a dichotomous event, where the scope and timing of involvement matters. The analysis distinguishes between three consecutive phases: i) idea generation; ii) specification and development; and iii) test, validation and launch. The explanatory variable in Model 3 is a discrete variable expressing six different combinations of the specific innovation phases that the supplier can be involved in. The variable ranges from 0, indicating no involvement, to 6, indicating involvement in all phases.

The analyses only concern firms' involvement in innovation activities in the customer firm that is identified as *the* most important customer by the supplier firm.[3]

Table 1 provides an overview of the included variables.

[3] There are no general criteria in the survey defining which customers should be considered the most important. The supplier firms may thus have used different criteria for identifying their most important customer. However, 85.9 percent of the respondents identified a customer that accounted for a large proportion of turnover and/or was a long-term customer, as their most important customer.

Table 1: Summary statistics of regression variables (unweighted)

Percentage of supplier firms with product innovation 2011-2013		33.49
Percentage of supplier firms with product innovation 2008-2010		45.41
Percentage of suppliers that are involved in customers innovation activities		63.68
Percentage of suppliers that are involved in their customers'	Idea generation (IG) only (i)	6.64
	Specification and development (S&D) only (ii)	13.74
	Test, validation and launch (TV&L) only (iii)	4.27
	IG + S&D (iv)	6.64
	S&D + TV&L (v)	19.90
	IG + S&D + TV&L (vi)	21.33
Percentage of suppliers that are sub-suppliers		45.87
Percentage of suppliers in manufacturing industries		74.77
Percentage of firms with most important customer located in	Denmark	61.68
	Nordic countries	7.91
	Germany, UK, France, Italy, Spain, Portugal or Poland	14.02
	Rest of the World	17.29
Percentage of turnover generated by customer (log)	Mean	2.75
	Standard Error	1.01
	Min.	0
	Max.	4.61
Duration (years) of relation with customer (log)	Mean	2.45
	Standard Error	0.98
	Min.	0
	Max.	5.01
In-house R&D expenses (log)	Mean	3.37
	Standard Error	4.39
	Min.	0
	Max.	12.89
No. employees (log)	Mean	4.19
	Standard Error	1.18
	Min.	0
	Max.	7.96

Because the dependent innovation variable refers to the same period as the explanatory variables (with the exception of the variable expressing previous innovation activity), the following analyses can only explore *relations* between supplier firms' involvement in customers' innovation activities and the suppliers own product innovation activities, whereas inferences about *causality* must be regarded as propositions only.

Empirical results

Before testing the hypotheses regarding the relation between firms' involvement in customers' innovation activities and the firms' own innovation activities, we explore what characterises the firms that become involved in their customers' innovation activities. This is done in order to explore whether it is the already innovative supplier firms that get involved in their customers' innovation activities.

Table 2: Regression results – Model 1

Dependent variable: firm's involvement in customers' innovation activities – binary variable

		Estimate		SE
Constant		-1.88	***	0.39
Firm was product innovative in previous period		0.23	***	0.09
Turnover generated by customer (log)		0.56	***	0.08
Duration of relation with customer (log)		0.09		0.08
In-house R&D (log)		-0.08	***	0.02
No. employees (log)		0.31	***	0.07
Industry (benchmark: manufacturing)		0.33	***	0.09
Location of customer (benchmark: Denmark)	Nordic countries	-0.75	**	0.22
	Selected EU countries[#]	-0.19		0.18
	Rest of the World	1.16	***	0.22
Number of observations used		209		
Log-Likelihood		-579.33		
R^2 (max-rescaled)		0.44		

[#] Germany, UK, France, Italy, Spain, Portugal, Poland

Table 2 shows that supplier firms, which have own experiences with product innovation, expressed as successful product innovation in the previous period, are more likely to become involved in their customers' innovation activities than non-product innovate firms. In other words, there is a pre-selection of suppliers, where innovative suppliers are more likely to be involved in their customers' innovation activities. Firm size is also positively related to the likelihood of being involved in customers' innovation activities. Firms' involvement in customers' innovation activities is positively related to the proportion of turnover generated from that customer, implying that the more important a customer is in terms of turnover, the more likely is it that the supplier firm is involved in this customer's innovation activities.

Duration of the supplier-customer relationship, on the other hand, has no significant influence on the likelihood of involvement in customers' innovation activities.

Rather surprisingly, a firm's in-house R&D activity is negatively related to involvement in customers' innovation activity. Service firms are more likely than manufacturing firms to be involved in customers' innovation activities.

If the customer is located in a Nordic country, then it is less likely that the supplier firm will be involved in this customer's development activities compared to when the customer is located in Denmark. However, it is considerably more likely that a firm will be involved in its customer's development activities if this customer is located in the rest of the world. This is an interesting finding since it challenges the assumption that geographical proximity is important for inter-firm learning. A likely explanation is that the collaborating firms are cognitively proximate (Boschma, 2005).

Turning to testing the hypotheses regarding the relation between firms' involvement in customers' development activities and the firms' own innovation activities, Table 3 supports the learning hypothesis (H1), finding that there is a positive and statistically significant relation between a firms' involvement in customers' innovation activities and this supplier firm's own product innovation activities (odds ratio 1.6). The supplier's previous product innovation activity, however, is more influential on current product innovation activities (odds ratio 3.1), thus indicating that although there is an effect from involvement in customers' innovation activities, this involvement is not in itself the most decisive factor for firms' innovation capabilities.

Suppliers' dependence on their most important customer, expressed as turnover generated by this customer and duration of the relation with the customer, is negatively related to suppliers' own innovation activities. Dependence on the customer being negatively associated with suppliers' own innovation activities is in accordance with expectations. This is an important finding stressing that too much stability in a relation may dull suppliers' innovation effort. However, there is no significant effect of the firm being a

sub-supplier, which is the third expression of supplier dependence, even though sub-suppliers customize their products to the particular customer, which might lead to a higher supplier dependence on the customer.

Table 3: Regression results – Models 2 and 3

Dependent variable: firm has been product innovative 2011-2013 – binary variable

		Model 2			Model 3		
		Estimate		SE	Estimate		SE
Constant		-0.33		0.47	0.20		0.53
Involvement in customer's innovation activities		0.25	**	0.11			
Scope and timing - Involvement in specific phases of customer's innovation activities (benchmark: no involvement)[##]	Idea generation (IG) only (i)				-0.46		0.33
	Specification and development (S&D) only (ii)				0.55	**	0.27
	Test, validation and launch (TV&L) only (iii)				-0.71		0.47
	IG + S&D (iv)				0.35		0.34
	S&D + TV&L (v)				-0.78	**	0.34
	IG + S&D + TV&L (vi)				1.21	***	0.21
Supplier was product innovative in previous period		0.57	***	0.10	0.52	***	0.10
Supplier dependence on customer:							
Sub-supplier		0.00		0.10	0.04		0.11
Turnover generated by customer (log)		-0.23	**	0.10	-0.41	***	0.22
Duration of relation with customer (log)		-0.61	***	0.11	-0.65	***	0.11
In-house R&D (log)		0.30	***	0.03	0.31	***	0.03
No. employees (log)		0.00		0.09	-0.03		0.09
Service industry (compared to manufacturing)		-0.37	***	0.12	-0.39	***	0.13
Location of customer (benchmark: Denmark)	Nordic countries	-0.94	***	0.32	-0.80	**	0.34
	Selected EU countries[#]	0.11		0.22	0.03		0.23
	Rest of the World	0.53	***	0.20	0.59	***	0.22
Number of observations used		209			208		
Log-Likelihood		-569.16			-567.88		
R^2 (max-rescaled)		0.84			0.87		

[#] Germany, UK, France, Italy, Spain, Portugal, Poland

[##] The combination of idea generation and test, validation and launch phases (IG + TV&L) has been excluded because of very few observations in this category.

Also as expected, the suppliers' in-house R&D is positively related to their innovation activity. Rather surprisingly, no association between firm size and innovation activity is detected. This might be due to the fact that the R&D variable to a large extent captures the size effect, since R&D expenses and firm size are correlated. Manufacturing firms are more likely to be product innovative than service firms.

Firms with their most important customer located in a Nordic country are less likely to be product innovative, whereas firms with their most important customer located in the rest of the World are more likely to be product innovative, compared to when the most important customer is located in Denmark.

However, as argued previously, Hypotheses 1 and 2 on learning and exhaustion effects of involvement in customers' innovation activities may be too simplistic. By assuming that it is simply a question of being involved or not, the possibilities of being able to balance learning and exhaustion are ignored.

Model 3, where all combinations of involvement in different development phases are analyzed, confirms Hypothesis 3 stating that the scope and timing of suppliers' involvement in customers' innovation activities does in fact matter. Most noticeable is it that suppliers' involvement in *all* development phases in the customer firms, from idea generation over specification and development to test, validation and launch, by far is the most favorable scope and timing of involvement in terms of relation to supplier firms' own product innovation activities (odds ratio 4.0).

Whereas the literature has emphasised the importance of early supplier involvement from the point of view of the customer, we find no support for early involvement only – here expressed as involvement in the idea phase - being beneficial from the supplier firm's point of view. Early involvement is only positive if the supplier stays involved throughout the entire development process. Seen from the existing literature on early supplier involvement, which suspects a positive impact for customer firms as well as for suppliers from early involvement (i.e. Johnsen, 2009), it is interesting that the importance from early involvement seems different from a supplier perspective. It is worth noticing that among the sampled firm used in the present analyses, only a small proportion of suppliers participate in the idea phase only.

If suppliers are involved in one development phase only, specification and development is the most likely phase to be involved in. We find a positive relation between being involved in the customer's specification and development phase only, and the firm's own product innovation activities (odds ratio 2.1). Involvement in the specification and development phase combined with the test, validation and launch phase is, on the contrary, negatively associated with the firm's innovation activities. A potential explanation of this finding is that there is a non-linear tradeoff between exhaustion and learning, which is related to the devotion of resources relative to learning opportunities – implying that the involvement in two development phases in the customer firm commands considerable resources in the supplier firm, which exceed the learning opportunities from this scope of involvement. In essence, this supports Boisot's (1995) point about positive as well as negative effects being at play at the same time in the relationship. Thus, the supplier firm may be linked to the customer in an unequal power relation (Helper & Sako, 2010), because the customer remains in control as long as the supplier is not involved in all major development phases.

The results regarding previous innovation activities, customer dependence, in-house R&D, firm size, industry and customer location are similar in Models 2 and 3.

The finding that involvement in customers' innovation activities is most positively related to suppliers' own product innovation activities when the involvement is broad in scope and covers all major phases of the development process is in line with the literature emphasizing that innovative discovery requires openness and reciprocity and that a shared pool of innovation insights leads to benefits for all parties involved (Van de Ven, 1986; Franke et al., 2013). The finding also indicates that a close and broad-spanning cooperation between customers and suppliers serves to reduce the likelihood of an exhaustion-inflicting relation between suppliers and customers.

Conclusions

This paper contributes to the literature on supplier involvement in customer innovation by taking the often-neglected supplier perspective. The analysis shows that it is not always beneficial for suppliers to be involved in their customers' innovation process. Becoming involved is an option that should be selectively pursued by suppliers.

There may indeed be a learning effect for suppliers from participating in customers' innovation activities, as measured from their own innovation activities. The effect remains even when it is taken into account that customers tend to select suppliers, which are already innovative. The results show that the conditions of supplier involvement matters for the relation between involvement in customers' innovation activities and suppliers' own innovation activities. When suppliers are involved in their customers' innovation activities, they are not only receiving learning benefits, but they are also committing resources as suggested by the exhaustion perspective on collaborative innovation.

The analysis shows that rather than speaking of learning and exhaustion effects as mutually exclusive, both may in fact play a role in determining the net benefits for suppliers. These net benefits seem to be contingent on the scope and timing of the suppliers' involvement in customers' innovation activities. With respect to the scope of participation, suppliers that participate throughout all phases of their customers' innovation activities are likely to benefit. So do suppliers, which limits their participation to one specific phase: specification and development, albeit to a lesser extent. With respect to the timing of involvement, there is a positive effect for suppliers from early involvement only if the suppliers stay involved throughout the entire development process.

The results indicate that there are several important issues to consider with respect to managing relationships to customer firms. First, if a supplier is highly dependent on a customer in terms of duration of the relation and share of turnover, then the supplier is likely to be involved in the customers' innovation activities but is at the same time less likely to introduce own innovations compared to other suppliers. This

may be caused by limited innovation incentives and learning opportunities due to lock-in. The second pitfall concerns the scope and timing of involvement. Early involvement is important, but not sufficient for suppliers in order to reap the innovation benefits from contributing to customers' innovation activities. Suppliers that are involved in all phases of their customers' innovation process are more likely to be innovative than other suppliers. This suggests that suppliers should avoid being stuck in the middle, but rather aim at strategies which either involve limited or comprehensive contributions to their customers' innovation process.

The findings are relevant for research on collaborative innovation and supplier involvement. The study illuminates how suppliers are affected from participation in customer firms' innovation activities, in order to nuance the innovation management literature's rather one-sided focus on the benefits of collaborative innovation. The results may help in the further exploration of the effect of being involved as a supplier in a customer firm's innovation activities. The paper also contributes to the existing stream of literature on learning benefits from innovation collaboration and provides a quantitative empirical grounding for other research results, which are often more anecdotal in nature. Finally, by taking a process view and addressing the role of scope and timing in supplier involvement we both extend existing studies of early supplier involvement that take the customer's perspective and challenge the literature, which tends to treat involvement as a dichotomous decision. In this paper, it is shown that involvement should be considered as a balancing act.

There are limitations to the study as well. First, the empirical context is Denmark - a small, open and mature economy with an extensive supplier base -, which may have an impact on the transferability of the findings to other national contexts. Secondly, the conclusions are based on a sample of a little more than 200 firms. Despite these limitations, the data and findings are novel and clearly warrant further investigation.

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