

How SMEs can benefit from supply chain partnerships

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Abstract – In recent literature on supply chain partnerships in small and medium-sized enterprises (SMEs), there is controversy regarding the benefits of these partnerships. To resolve this controversy explicit information is needed on the implementation of these partnerships by SMEs; an area that, thus far, has received little academic attention. In this paper, we examine different business functions (production, marketing and sales, purchasing and logistics, R&D, and finance) within a supply chain partnership. We collected data for each individual function from 279 high-tech SMEs and examined the relationship between the specific types of partnerships and the overall performance of the SMEs. The results indicate that it is only in the area of R&D that partnerships have a significant positive effect on overall firm performance. The results imply that SMEs primarily can benefit from particular types of supply chain partnerships, i.e. R&D partnerships. The results contribute to the debate in the literature by explaining why many SMEs were found not to benefit from these partnerships. We also provide implications for firms and how SMEs can better utilize SCM.

Keywords: Supply Chain Management (SCM); Supply Chain Partnership; SMEs, high-tech

1. Introduction

Firms have increasingly used supply chain partners as a source of competitive advantage (Spekman *et al.*, 1998; Lummus and Vokurka, 1999). SCM is a form of managing inter-firm relationships aiming at creating relational rents and competitive advantage, where relational rent is defined as “a supernormal profit jointly generated in an exchange relationship that cannot be generated by either firm in isolation and can only be created through the joint idiosyncratic contributions of the specific alliance partners” (Dyer and Singh, 1998). Most studies on partnerships in the context of supply chain management (SCM) focus on large enterprises (Thakkar *et al.*, 2008), with the exception of a few recent articles (Arend and Wisner, 2005; Arend 2006; Tan *et al.*, 2006; Koh *et al.*, 2007; Bhagwat and Sharma, 2007). In recent literature on SMEs, there has been controversy over the benefits of supply chain partnerships for SMEs.

The controversy surrounds the extent to which SMEs can genuinely benefit from supply chain partnerships. There is research evidence that describes how SMEs can benefit from supply chain partnerships. To build their own innovative capability and to reach their markets, high-tech SMEs need access to external skills and technological knowledge even more than larger firms (So and Sun, 2010; Lambert and Schwieterman, 2012). For example, in a survey of Chinese manufacturing SMEs, Zeng *et al.* (2010) found that inter-firm cooperation has the most significant positive impact on the innovative performance of SMEs. Thus partnerships provide SMEs with: access to comprehensive and external expertise, can help them solve business problems and allows them to engage in learning networks. There is, however, some evidence to suggest that SMEs do not benefit from supply chain partnerships (at least not to the same extent as large firms). In a seminal study, Arend (2006) found that there is a negative relationship between SCM and the accompanying partnerships, due to the management, control and support

requirements associated with these partnerships, which reduce the flexibility of the SMEs (see also Vaaland and Heide, 2007).

The aim of this paper is to address this controversy by examining partnerships in greater detail and describing both positions. We examine the implementation of supply chain partnerships in different functions of SMEs. Based on functions involved in supply chain partnership, we distinguish different types of partnerships and assess their effect on overall SME performance. At present, there is a limited understanding of supply chain partnerships themselves in SMEs, and existing literature does not help SMEs deal with SCM strategies in practice. We look at the implementation of supply chain partnerships and, in so doing focus on the function within the SME that is involved with the partnership. It has been shown that a supply chain partnership involves more than logistics and purchasing alone and may include other business functions such as marketing and sales, production, research and development (R&D) and finance (Cooper *et al.*, 1997; Croxton *et al.*, 2001; Mentzer *et al.*, 2001; Lambert, 2008; Lambert and Schwieterman, 2012; Rezaei and Ortt, 2012). It is hard to assess the suitability of supply chain partnerships for SMEs without looking at typical functions of the organization. It seems more rational to evaluate partnerships for different business functions as it is then possible to find where partnerships pay off. Within this paper we specifically address the following research question:

What is the effect of SCM partnerships involving separate business functions on the SME's overall performance?

For this research project we collected data on several partnership aspects for each individual function from 279 high-tech SMEs and examined the relationship between the specific types of partnerships and the overall performance of the SMEs. Our research contributes to the stream of literature on supply chain partnerships and specifically informs the debate on how SMEs can

more fully exploit their partnerships (Arend, 2006; Lambert 2008; Lambert and Schwieterman, 2012). Our findings reveal that business functions within individual firms can have different characteristics in terms of different partnership components (e.g. trust, risk, and contract style), all of which are found to be important to partnerships (Lambert, 2008). This means that business functions involve different propensities to collaborate with supply chain partners, which is a notion that has serious implications for managers establishing supply chain partnerships. Our findings should help managers develop more appropriate partnering strategies, and improve how they manage cross-functional partnerships, for example in new product development (Olson *et al.*, 2001; Eng, 2006).

The next section covers the theoretical background for building a functional partnerships model. The methodology and data collection are described in section three. In section four, confirmatory factor analysis is used to test the proposed functional partnerships model. The effects of partnership in different functional areas on the overall performance of SMEs are explored using regression analysis in section five. Section six, finally, contains the discussion, managerial implications and conclusions.

2. Theoretical background

Supply chain management has gained considerable attention in recent years. It has gradually emerged from the logistics literature and has evolved into a comprehensive concept that covers all the business activities within and between partners in a supply chain. This section is divided into three parts. First, we show how SCM extends beyond purchasing and logistics. Secondly, we examine and describe the supply chain partnership and its components. In the third part, the effect of supply chain partnership on firm performance is reviewed.

2.1 SCM versus logistics

In 1986, the Council of Logistics Management (CLM), defined logistics management as: “the process of planning, implementing, and controlling the efficient, cost-effective flow and storage of raw materials, in-process inventory, finished goods, and related information flow from point-of-origin to point-of consumption for the purpose of conforming to customer requirements.”

SCM, on the other hand, is defined as the systemic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular firm and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole (Mentzer *et al.*, 2001). Considering the business function as production, marketing and sales, purchasing, logistics, R&D, and finance, it becomes clear that logistics activities are covered under a broader umbrella of SCM. The CLM which became the Council of Supply Chain Management Professionals (CSCMP) in 2005 (the leading global association for supply chain management professionals), now has a modified definition for logistics management as: “logistics management is that part of supply chain management that plans, implements, and controls the efficient, effective forward and reverses flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirements.” The new definition explicitly identifies logistics as part of SCM.

The importance of considering different traditional business functions has been highlighted by several researchers. For instance, Lummus and Vokurka (1999) argue that “managing the supply chain means managing across traditional functional areas in the company and managing interactions external to the company with both suppliers and customers”. Cooper *et al.*, (1997) recognized a need for integrating business functions which goes much beyond logistics. As an

example, they mentioned ‘new product development’ where all business functions including R&D, marketing and sales, purchasing, logistics, production, and finance should be ideally involved. It is then also needed to involve external organizations in new product development which in sum implies the involvement of all the business functions within and between the supply chain partners.

Despite such progress in understanding and recognizing the inclusion of all the business functions, most studies on supply chain partnerships focus on logistics and purchasing (see, for example, Heide and John, 1990; Noordewier *et al.*, 1990; Stevenson and Jarillo, 1990; Ellram, 1995; Stump and Sriram, 1997; Miller and Kelle, 1998; Carr and Pearson, 1999; Gao *et al.*, 2005; Caniels and Gelderman, 2007; Caniels *et al.*, 2010), which can be attributed to the dominant role of these functions in buyer-supplier relationships. A few focus on other functional areas, such as R&D, marketing and sales, production and finance (Gen and Cheng, 1996; Rezaei and Ort, 2012), which can also play important roles in partnerships. Ruekert and Walker (1987) found, for example, that marketing plays a co-coordinating role in connecting all the other functional departments to the outside environment. A study by Hagedoorn (2002) showed that there has been a steady growth pattern in the number of R&D partnerships, especially in high-tech industries, during the last four decades. For partnerships in R&D, we refer to Ingham and Mothe (1998), Hagedoorn and Van Kranenburg (2003), Roijackers and Hagedoorn (2006), Busom and Fernández-Ribas (2008), Frankort *et al.* (2012), Azadegan *et al.* (2013) among others. For partnerships in marketing, we refer to Brennan and Turnbull (1999), Wang and Kess (2006). For partnerships in production, we refer to Meixell and Wu (2004), Moyano-Fuentes *et al.*, (2012). A limitation of the existing literature is that it evaluates one or only a few business functions and does not provide a broad picture of what is actually happening between a firm and

its supply chain partners, hence this does not help the firm to improve its performance with respect to different functional areas.

2.2 Supply chain partnerships

Today, most organizations including SMEs recognise the importance of implementing supply chain partnerships, nonetheless, they often do not know precisely what and how to optimise their supply chain partnerships. This is mainly because it is not clear to them what characterises an effective supply chain partnership (Li *et al.*, 2006). Partnership is a central concept in supply chain management, and is the driving force of effective SCM (Horvath, 2001). Generally speaking, it is a type of inter-organizational relationship that is placed in the middle of a continuum from contractual arm's length relationship to vertical integration (Ellram and Cooper, 1990). Apart from the central position the concept occupies in SCM studies, there are a few studies that examine the concept itself, and its operationalization (Anderson and Narus, 1990; Spekman *et al.*, 1998). Here, we begin by reviewing some of the definitions of this concept found in the literature (see Table 1).

-----Insert Table 1 approximately here-----

As becomes clear from the definitions, partnership is mainly seen as a type of relationship between *organizations*. To understand how these partnerships are implemented, we look at the business functions involved. We include all the traditional business functions in the process and implementation of partnerships (Mentzer *et al.*, 2001). More precisely, partnership is by nature a multifaceted construct. In the literature different components of partnerships are suggested (see for example Mentzer *et al.*, 2001; Rinehart *et al.*, 2004). One of the most comprehensive lists of components, which is also used in our study, was proposed by Lambert (2008). It should be mentioned here that while Lambert (2008) has proposed these components to evaluate supply

chain partnerships in general, we particularly use them for different functional partnerships. Here we discuss the partnership components and their importance.

- *Planning.* Joint planning has been shown to have a positive effect on buyer and supplier performance (Cai *et al.*, 2009) through capturing the synergy of the collaboration. Partnerships involve some degree of joint planning. With a high level of joint planning, each party participates in the other's business planning (Lambert, 2008). The planning is used to align the supply chain partner and to make operating decisions (Cao and Zhang, 2011). The contribution to success of joint planning has been recognized by several researchers (see, for example, Cooper and Ellram, 1993; Ellram and Cooper, 1993; Cooper *et al.*, 1997; Näslund and Hulthen, 2012). SMEs may benefit from some of the longer-term planning routines used by larger firms.
- *Joint operating controls.* Joint control helps all the supply chain members to eliminate waste and enhance their customer services (Min and Mentzer, 2004). Within a partnership, partners are to some extent able to change each others' operations to improve the relationship. Together, joint planning, and joint operating control move the firm in the desired direction (Cooper *et al.*, 1997; Lambert, 2008).
- *Communication and information sharing.* Information sharing improves the coordination between supply chain processes, enhances the level of supply chain integration and affects the performance of supply chain members in terms of cost and service level (Li and Lin, 2006; Carr and Kaynak, 2007). Previous studies have shown that information sharing is recognized as a key requirement of a successful implementation of supply chain management (Moberg *et al.*, 2002; Zhao *et al.*, 2002; Fawcett *et al.*, 2007; Lambert, 2008). *Risk/reward sharing.* Within a partnership, partners should be assured that the reward/benefits and

risks/costs are shared. The balance between sharing the risks and rewards is one of the key motivating factors for establishing and maintaining supply chain partnerships (Matopoulos *et al.*, 2007; Lambert, 2008), and it is one of the most important factors contributing to a close collaboration between supply chain partners (Matopoulos *et al.*, 2007).

- *Trust*. Trust has a positive effect on the performance of SCM (Kwon and Suh, 2004, 2005) and helps overcome mutual difficulties (Zineldin and Jonsson, 2000). It is a key factor in building long-term relationships (Coulter and Coulter, 2002), a “binding force” in buyer-supplier relationships (Agarwal and Shankar, 2003) and even a necessary condition for inter-organizational relationships (Cheng *et al.*, 2008). SMEs feel particularly vulnerable given their limited resources so this is of critical concern to them.
- *Commitment*. Partners, and especially SMES, should not have be worried about being replaced (Lambert, 2008). Committed partners are more willing to sustain the relationship (Tan *et al.*, 1999). When commitment is encouraged within an organization, the organization works together with other organizations to implement a supply chain partnership (Mello and Stank, 2005), in other wordscommitment of supply chain partners is helpful in the integration of the SCM business process (Wu *et al.*, 2004), and improving the firm performance (Krause *et al.*, 2007).
- *Contract style*. Legal contracts have been recognized as improving the commitment between buyer and supplier, as well as the relationship satisfaction (Carey *et al.*, 2011). Often, there is no formal contract in a partnership (Lambert, 2008). Palay (1985) mentioned several advantages of having an informal contract, including: it is “more timely than other strategies”, and it “provides the parties a means of making adjustments in relatively short order”. Furthermore, shorter contracts will appeal to SMEs.

- *Scope.* Cravens et al., (1993) showed that understanding the scope of a partnership is key to analyzing the formation, operation and effectiveness of the partners. The number of value-added steps and the amount of businesses covered in the relationship show the scope of the partnership (Lambert, 2008). Skjoett-Larsen *et al.* (2003) found that, to understand a partnership better, both its depth and scope should be studied.
- *Financial Investment.* Matthyssens and Van den Bulte (1994) found that joint investment in new product development may improve product quality. Furthermore, joint investment, especially in complementary resources, results in a more efficient use of resources (Prior, 2012), and accelerates the effect of supply chain partner innovativeness on product innovation strategy of firm (Oke et al., 2013). Clearly limited financial assets is a common feature of SMEs.

In the previous section we discussed the importance of considering all the business functions in the context of SCM. It is now possible to operationalize the role of different business functions in partnerships by measuring each partnership component for different business functions separately (see Figure 1). Figure 1 suggests considering all the components of the partnership, mentioned above, for different business functions. It is likely that while a firm shares information with its R&D partners to a high extent, it shares information with production partners to a lower extent, which is expected to have different effects on firm performance. The conceptual model proposed in Figure 1 enables us to measure the degree of partnership for different business functions of a company separately. This in turn facilitates evaluation of different supply chain partnerships.

-----Insert Figure 1 approximately here-----

2.3 Supply chain partnership and firm performance

Firms enter into a supply chain partnership, as a long-term relationship with their key partners, with the objective of enhancing their overall performance and competitive advantage. It is, however, not clear if firms, especially SMEs, can improve their performance through their supply chain partnerships. Several studies have found positive relationship between supply chain partnerships and firm performance. For instance, Li *et al.* (2006) collecting data from a sample of 196 firms (of different sizes) and found that supply chain management practices including strategic supplier partnership, customer relationship, information sharing, and postponement has a positive effect on organizational performance of the firm (marketing performance, and financial performance). From a sample of 127 firms (of different sizes), Srinivasan *et al.* (2011) found a positive impact of buyer-supplier partnership quality on supply chain performance of the firm. They also found that the positive effect of partnership quality on supply chain performance of the firm weakens when there is a greater level of uncertainty. Accommodating uncertainty in supply chains raises the issue of flexibility (Singh and Sharma, 2014). SMEs have been found to suffer from a lack of flexibility to adapt their supply chain management practices effectively (Quayle, 2003). This may help to explain why SMEs cannot always benefit from their supply chain partnerships. Wisner (2003), collecting data from US and European companies found a significant relationship between immediate and second-tier supply chain management strategies and firm performance. He argued that, to improve their market share, competitiveness, product quality, and customer service, firms should assess and, if necessary, modify their firm's immediate supplier and customer relationship capabilities. Firms should also improve and maintain partnership capabilities through information sharing and exchange, and sharing future strategic plans. Nyaga and Whipple (2011), in an empirical study found that the quality of the

relationship with key suppliers has a significant positive impact on the operational performance of the firm. However, other studies, which have considered SMEs, provide controversial findings. While a few studies support the positive relationship between engagement of SMEs in SCM and their performance, most studies have found a negative effect of supply chain partnership on SME performance. Analyzing data from 203 Turkish SMEs, Koh *et al.* (2007), found that two classes of SCM practices (“strategic collaboration and lean practices” and “outsourcing and multi-suppliers”) have a direct positive and significant impact on the operational performance of SMEs. These two classes of SCM practices, however, are found not to have a significant and direct impact on SCM-related organizational performance. Arend and Wisner (2005) questioned the fit between supply chain management practices with SMEs. They collected data from a sample which included 200 senior managers in SMEs. Their findings suggest that engagement in SCM hinders SME performance. They offered several explanations for their findings as follows.

- *Difference in implementation of SCM by SMEs:* SMEs implement SCM differently compared to large enterprises (LEs). For example, SMEs do tend to develop deep involved supply chain partnerships, hence they do not benefit fully from SCM in the same way as LEs. In sum SMEs cannot effectively implement SCM.
- *SME strategy:* in general, SMEs do not consider SCM practices as a way to compensate for their weaknesses in strategic areas where they would be strong. In sum, SMEs do not practice SCM in a strategic way.
- *Context:* SMEs engage in SCM for convenience and easy of operating. Thus poor fit between SMEs and SCM may be associated with partner selection criteria. SMEs focus on short-term criteria for partner selection.

Following Arend and Wisner's (2005) seminal study to investigate the extent SMEs use modern planning and control methods (e.g. e-solutions with suppliers and customers) to meet SCM challenges, Vaaland and Heide (2007) conducted a survey among 200 Norwegian companies (126 SMEs and 74 LEs). They compared SMEs with LEs in using modern planning and control methods. Among other differences between SMEs and LEs, they found that (1) the requirements and utility of formalized planning and control systems are less important for SMEs; (2) upstream integration is of less importance for SMEs; (3) vendor-managed inventories (VMI) are less important for SMEs. Their findings show that in general SMEs place less importance on methods for modern planning and control for successfully implementing SCM, which is in-line with the findings of other research on evaluation fit between SCM and SME (see, for example, Quayle, 2003).

The discussions above illustrate the dilemma facing SMEs. On the one hand it seems that supply chain partnership could help SMEs leverage their capabilities through exploiting the resources of their partners as a way of compensating for their own lack of resources. On the other hand engaging in supply chain partnership is by itself an activity which is costly and needs specific resources. The extant literature offers limited insight of the engagement of SMEs in SCM. Research is required to examine SMEs characteristics (especially their lack of resources), and to show how they can benefit from supply chain partnerships. The decomposing of supply chain partnerships into different functional partnerships and then evaluating their effectiveness for SMEs provides a way of gaining these insights; this is the main aim of this study.

3. Methodology and data collection

The population of this study consists of Dutch SMEs in high-tech industries. We chose high-tech SMEs as research subjects based on a number of important characteristics of high-tech SMEs,

which make them more relevant and interesting for our study: (i) high-tech SMEs are most competitive firms of today (Wu and Weng, 2010); (ii) high-tech SMEs are important for stimulating the economic and employment growth (Bommer and Jalajas; 2002, Nunes *et al.*, 2012), mainly through creating and implementing technological innovations (Kourtit and Nijkamp, 2011); (iii) high-tech SMEs operate mainly in highly innovative sectors, and incline to be high-growth (Love and Ganotakis, 2013); (iv) high-tech SMEs are operating in a very dynamic business environment (Gedajlovic *et al.*, 2012); (v) high-tech SMEs internationalize relatively early (Love and Ganotakis, 2013). For the purpose of this study, we adopt the European Commission's definition of SMEs: "enterprises which employ fewer than 250 persons and which have an annual turnover not exceeding 50 million euros, and/or an annual balance sheet total not exceeding 43 million euros" (European-Commission, 2003). For these SMEs, the partnerships with their supply chain partners (in different business functional areas: marketing & sales, research & development, production, purchasing & logistics, and finance) were investigated. The population was selected based on the criteria *eligibility* (i.e. the selected cases must belong to the theoretical domain), *prioritization* (i.e. the population should be selected from a part of the domain that has not already been tested, or from a part which has of more significance), and *feasibility* (the population should be selected taking the availability and accessibility of the data into account).

To draw a sample, we used the Kompas database containing nearly 220,000 Dutch firms, about 200,000 (91%) of which are SMEs. To include only high-tech manufacturing SMEs, we included 17 of the 99 product categories in the database¹. The selection procedure for high-tech firms is based on Medcof's classifications for high-tech industries (Medcof, 1999).

¹ A complete list of the product categories is available upon your request.

A four-page questionnaire was devised including items on partnerships with supply chain partners for different functional areas (suppliers, R&D partners, production partners, financial partners, marketing and sales partners, and logistics partners) and overall firm performance. A panel of professionals with substantial knowledge about the topic was asked to review and modify the items. As a result, some statements were rewritten. Next, the questionnaire was pretested in a series of personal interviews based on the Three-Step Test-Interview approach (TSTI) (Hak *et al.*, 2006) with managers of two high-tech SMEs. After this pretest, further items were revised. Finally, the questionnaire was translated into Dutch by a professional editor, and revisited by one of the authors of this paper to correct potential translation errors.

There were 45 items in total to measure partnerships between firms and their partners with respect to five different functional areas (9 items per each functional area). Four items were used to measure overall firm performance. For all the items, a 7-point Likert scale was used (see Table 3 and Table 6, respectively). We sought to reduce the potential for single-respondent bias by focusing on start-up founders and/or CEOs of SMEs who have a good understanding of their firm's partnerships and tend to be more reliable sources of information than their subordinates (Phillips, 1981; Tan, 2002). Given their position and responsibility, it was assumed that the respondents had access to the information requested in the survey.

The questionnaire, along with a cover letter (both in Dutch), and a pre-addressed stamped envelope was sent to senior managers of 6000 randomly selected SMEs in high-tech industries. In total, 304 questionnaires were returned, which is generally consistent with the response rates in SME mail surveys (Karagozoglu and Lindell, 1998; Kundu and Katz, 2003). From these questionnaires, 25 were excluded (six did not satisfy the inclusion requirements: the number of employees and/or turnover exceeded those of SMEs, and 19 were excluded because of more than

10 percent of the data was missing). In Table 2, the descriptive statistics of the sample and the respondents are provided.

-----Insert Table 2 approximately here-----

Non-response and common method biases

To address potential non-response bias, several remedies have been suggested, one of the most commonly used is the non-response bias analysis proposed by Armstrong and Overton (1977)¹. Non-response bias means that, because the non-respondents are different from the respondents, the outcome of a study is not representative of the population from which the sample was taken. The main idea of non-response bias analysis is that the non-respondents are more similar to the late respondents than they are to the early respondents. Therefore, using an extrapolation method, we are able to estimate the magnitude of non-response bias. Here, we used the projected respondent method² to estimate the magnitude of the non-response bias. To implement the projected respondent method, we used the first two-thirds of our sample (186) as the first wave, and the last third (93) as the second wave. The results of the analysis show that there are no significant changes between the waves.

We also investigated the potential for common method biases, that is, having one person from each firm (CEO) answer all parts of the questionnaire (the partnership and the performance items). Common method bias results from the way of measuring, in our case the method to measure constructs in a self-completed questionnaire. The following measures were taken to

¹ Despite its robustness and simplicity, however, the procedure is often misapplied. In a study of 50 papers that referred to this procedure, 49 of these papers failed to properly use this simple procedure (Wright and Armstrong, 2008)

² *Projected respondent*: This is an extrapolation method based on only two waves, using the third wave as a criterion. For this method, a linear extrapolation is made by plotting the averages for the first and second waves, and drawing a line to the cumulative percentage of respondents at the midpoint of the criterion (third) wave.

control for common method bias when designing the questionnaire: i) difficult terms in the questionnaire were defined; ii) examples were provided for complex items in the questionnaire; iii) extended questions were avoided (Podsakoff *et al.*, 2003) mainly based on the test interviews conducted in advance (Hak *et al.*, 2006). As a statistical remedy, we performed a check using *Harmon's single-factor test* (Podsakoff and Organ, 1986), as a result of which more than 6 factors (with eigenvalues greater than one) were extracted from the measurement items in this study. The factors account for 75.5% of the variance in total, the first of which accounts for 32.6% of the variance. As no single factor emerged from the factor analysis, and there was no one general factor that accounted for the majority of the variance among the measures, the results show that common method variance is not an issue.

4. Functional partnerships model

Confirmatory factor analysis (CFA) is used to test the model that specifies the aspects related to partnerships per business function. LISREL 8.80 (Jöreskog and Sörbom, 2007) is applied to test the goodness of fit of the model. To conduct the CFA for the model, as suggested by Schumacker and Lomax (2010), the following steps were taken: model specification, model identification, model estimation, model testing, and model modification.

4.1 Model specification

In this step the model is specified according to different hypothesized relationships between observed variables and hypothesized factors. In our study there were 45 observed variables (p) (nine components of partnership multiplied by five functional areas), and five factors (latent variables). In section 2.2 we listed nine components of supply chain partnership proposed by Lambert (2008). The idea is to measure these nine components for partnerships made for different functional areas (marketing and sales, R&D, logistics and purchasing, production,

finance). The five hypothesized latent variables are then: i) ‘partnership in marketing and sales’, ii) ‘partnership in R&D’, iii) ‘partnership in logistics and purchasing’, iv) ‘partnership in production’, and v) ‘partnership in finance’. In this model, observed variables that measure partnership aspects in a particular functional area are combined across aspects to form a latent variable that represents the overall partnership for each function. For example, the observed variables ‘planning in marketing and sales’, ‘joint operating control in marketing and sales’, ‘communication and information sharing in marketing and sales’, ‘risk/reward sharing in marketing and sales’, ‘trust in marketing and sales’, ‘commitment in marketing and sales’, ‘contract style in marketing and sales’, ‘scope in marketing and sales’ and ‘financial investment in marketing and sales’ are hypothesized to measure a single latent variable ‘partnership in marketing and sales’ (see Figure 1).

4.2 Model identification

Prior to estimating the parameters, it is necessary to solve the identification problem, which shows whether the factor loadings can be estimated. To this end, we should first assess the order condition, which means that the number of free parameters to be estimated has to be less than or equal to the number of distinct values in the sample variance-covariance matrix S . Here, we calculate the number of free parameters for the model.

The number of free parameters for the model = 45 (factor loadings) + 45 (measurement error variances) + 10 (correlation between the latent variables) + 90 (measurement error correlations) = 190.

The number of distinct values in matrix S is calculated as follows.

$$p(p+1)/2 = 45(45+1)/2 = 1035$$

The model meets the condition that the number of distinct values in the matrix S (1035) be greater than the number of free parameters of the model (190). However, it is also necessary to check the rank condition to fully identify a model. This condition is tested using LISREL 8.80 (Jöreskog and Sörbom, 2007).

4.3 Model estimation

After identifying the model, it is necessary to estimate the parameters. To estimate the free parameters, several procedures can be applied, such as maximum likelihood, generalized least square and weighted least square. We selected the maximum likelihood procedure, because, compared to other methods it produces reliable results in many circumstances (Hair *et al.*, 2006). We used the LISREL 8.80 program (Jöreskog and Sörbom, 2007) to estimate the parameters. Table 3 contains the standardized estimates for the model. It is also worth mentioning that a sample size in the range of 150-400 is suggested when applying the maximum likelihood method (Hair *et al.*, 2006); our sample size is 279.

4.4 Model Testing

When the parameters have been estimated, it is very important to check whether the specified model fits the sample data, for which several model-fit indices can be used. To assess the goodness-of-fit of the models we report multiple fit indices (see Table 4). χ^2 is a statistical test of the difference between the estimated covariance matrix and the actual observed covariance matrix. The maximum likelihood method minimizes this difference, and it is desirable to have smaller difference, hence an insignificant χ^2 value (Hair *et al.*, 2006). For our model χ^2 value (1490.96) is large relatively to degree of freedom (845) which resulted in a significant χ^2 value as it is expected to happen for large sample sizes ($N > 250$) and large number of observed variables ($p \geq 30$). Root Mean Square Error of Approximation (RMSEA) is a test which is used to correct

the tendency of χ^2 value to reject models with large N or p . Desirable values for RMSEA for $N > 250$, and $p \geq 30$ is the values below 0.07. For our model RMSEA is 0.052, with p -value = 0.18. Non-Normed Fit Index (NNFI), and Comparative Fit Index (CFI) are among the most widely used goodness of fit measures, values greater than 0.90 are desirable. In our model both are 0.98. According to a wide range of measures, the model is an appropriate description of the sample data, hence the specified model is confirmed.¹

-----Insert Tables 3 and 4 approximately here-----

It is important for the estimates to be significant. As can be seen from Table 3, all the estimates for the model are highly significant. Given these results, we are able to conclude that the model fits the sample data very well. Next, the construct validity of the five latent variables in the model is examined. To this end, we begin by taking a look at the mean and the standard deviation of the five constructs and the correlation between them (see Table 5).

-----Insert Table 5 approximately here-----

4.5 Construct Validity

Construct validity refers to the degree to which a measure assesses the construct it is purported to assess (Peter, 1981). Here, we discuss the construct validity for the model used in this study. To this end, we take face validity and nomological, convergent, and discriminant validity into account (Hair *et al.*, 2006).

- *Face validity and nomological validity*: as discussed before, we used a panel of experts to match the construct definition and item wording. Furthermore, the Three-Step Test-Interview

¹ We have also conducted a comparison study, comparing the proposed model in this paper with an “organizational model” where partnership is measured across the organization rather than its functional areas. The results of the comparison study shows the superiority of the functional model proposed in this paper. To see the results of the empirical comparison study refer to Rezaei (2012).

(TSTI) (Hak *et al.*, 2006) procedure was used to improve the wording and to ensure the face validity of the scales. Table 5 shows that all the correlations between the constructs are positive and significant, which shows the nomological validity of the constructs, as it is assumed that partnerships in different functional areas of the firm have a close and supportive relationship.

- *Convergent validity*: the items (observed variables) of a particular construct (latent variable) should converge or share a high common variance. Two main indicators of convergent validity are factor loadings and construct reliability (Hair *et al.*, 2006). As can be seen from Table 3, all the factor loadings for all the constructs are highly significant, which is the minimum requirement for convergent validity (Anderson and Gerbing, 1988). All the standardized factor loadings, except ‘commitment’ loadings, are higher than 0.5 (the cut-off point is 0.5 according to Bagozzi and Yi, 1988). For theoretical reasons, we included the ‘commitment’ items (please note that the ‘commitment’ loadings, although below 0.5, are highly significant). Although there are several reliability indicators (e.g. Cronbach, 1951), ‘construct reliability’ (CR) (Fornell and Larcker, 1981; Hair *et al.*, 2006) is mostly used in structural equation models. We calculated the CR for five constructs of the functional model. The results show excellent reliability scores as follows (CR greater than 0.7 show good reliability (Hair *et al.*, 2006)).

$CR_{\text{marketing and sales}} = 0.987$; $CR_{\text{research and development}} = 0.987$; $CR_{\text{purchasing and logistics}} = 0.987$;

$CR_{\text{production}} = 0.986$; $CR_{\text{finance}} = 0.986$.

- *Discriminant validity*: each construct should be distinct from the other constructs. One of the best ways to evaluate discriminant validity is to compare the variance extracted (VE) from all the combinations of two constructs with the square of the correlation between the two

constructs (Hair *et al.*, 2006). As there are five constructs in the functional model, the VE for the constructs was first calculated and then compared with their corresponding square of correlations. The VEs of the constructs obtained were:

$VE_{\text{marketing and sales}} = 0.51$; $VE_{\text{research and development}} = 0.50$; $VE_{\text{purchasing and logistics}} = 0.43$;

$VE_{\text{production}} = 0.40$; $VE_{\text{finance}} = 0.44$.

Comparing these VEs with the square of the correlation between constructs reveals that almost all the VEs are greater than their corresponding square correlations, which indicates discriminant validity (Fornell and Larcker, 1981). For example, both $VE_{\text{marketing and sales}}$ (0.51) and $VE_{\text{research and development}}$ (0.50) should be greater than the square correlation between ‘Partnership in marketing and sales (MS)’ and ‘Partnership in research and development (RD)’ ($(0.68)^2 = 0.46$).

To summarize, the results of the construct validity test provide strong support for the proposed functional model.

5. Functional partnerships and overall performance

To explore the effects of partnership in different functional areas on the overall performance of a company, we performed an OLS regression analysis ¹. Overall performance was measured using the observed variables: profitability, sales growth, employment growth, and market share. The results of the regression analysis show a highly significant and positive effect of ‘partnership in research and development (R&D)’ on overall performance. Other functional partnerships have no significant effect on the overall firm performance (see the last column of Table 6).

¹ To determine the potential existence of multicollinearity, the variance inflation factor (VIF) was examined. The largest VIF scores in all of the 5 regression models in Table 5 and Table 6 were 1.757 and 1.771, respectively (should be below the maximum level of 10.0 (Mason and Perreault, 1991)), indicating that there is no problem with multicollinearity in this study.

-----Insert Table 6 approximately here-----

We also conducted four separate OLS regressions ¹, in each case considering one item of the overall performance, and found approximately the same result (Table 6), which means that partnerships in R&D have a highly significant and positive effect on all the aspects of the overall performance of a firm (profitability, sales growth, employment growth, and market share). R&D partnerships have become dominant in high-tech industries over the last four decades (Hagedoorn, 2002). Miotti and Sachwald (2003) found that firms from high-tech sectors tend to partner more than firms in less R&D intensive sectors. Our results also show how important R&D partnerships are for high-tech SMEs. This finding also support the argument provided by Arend and Wisner (2005) that SMEs engage in supply chain partnerships that are easier for them. We found that partnerships in marketing and sales have a significant negative effect on a company's profitability. If we look at some of the other negative (although not significant) effects of other functional partnerships on the items of overall performance, the usefulness of our partnership operationalization becomes clear. Earlier studies have found a positive relationship between supply chain partnership and firm performance (Tan, 2002; Li *et al.*, 2006; Dehning *et al.*, 2007; Koh *et al.*, 2007), while some others concluded that SCM practices have a negative effect on firm performance (Arend and Wisner, 2005; Arend, 2006). Existing literature indicates that, in general, SMEs cannot benefit from SCM mainly because they tend to implement SCM differently compared to large enterprises (Arend and Wisner, 2005). In addition, SMEs lack the ability to adapt to SCM effectively (Quayle, 2003) and they are less concerned with methods supporting SCM (Vaaland and Heide, 2007).

The partnership operationalization per business function provides an interesting solution to this controversy. The proposed partnership is in fact a decomposition of company partnership into

separate functional partnerships. The results of this study show how functional partnerships have different effects on company performance. The conclusion from the regression analysis shows that high-tech SMEs in common with other SMEs do not benefit from SCM in marketing and sales, production, purchasing and logistics and finance. These results, together with the traditional emphasis on purchasing and logistics in supply chain management, explain why many previous studies have found that partnerships have a negative effect on overall performance.

Finally, our results also indicate that SMEs do benefit from partnerships in research and development (R&D). We think that this may be even more prominent in our study because we focused on high-tech SMEs. However, as mentioned by Lummus and Vokurka (1999), maximizing performance in one function may have a negative impact on overall performance. The findings thus highlight the importance of cross-functional teams to achieve overall SCM objectives (Morris and Paul, 1987).

6. Conclusions, managerial implications, and future research

Conclusions

We have shown that strategic partnerships with supply chain partners are important for high-tech SMEs, since they often lack the resources needed to master the knowledge regarding all components of complex products (Kaufmann and Tödtling, 2002). This study has focused on strategic partnerships between high-tech SMEs and their supply chain partners. Our research contributes to the stream of literature on supply chain partnerships and specifically informs the debate on how these functional partnerships vary in their impact on overall firm performance. (Arend, 2006; Lambert, 2008; Lambert and Schwieterman, 2012). We also show how SMEs can better exploit their supply chain partnerships.

Traditionally, several aspects of the organization as a whole are seen as important factors enabling these partnerships, for example the degree of information sharing, trust and commitment in the organization (Moore, 1998; Kwon and Suh, 2004). In this study of 279 high-tech Dutch SMEs, items reflecting the aspects of partnership were assessed for each individual organizational function. From a scientific perspective, this is highly relevant because distinguishing between functional partnerships reveals why some earlier studies show mixed results with regard to the effect partnerships have on the overall performance of SMEs.

Further credibility of the functional view is provided when we see that some of the functional variables, especially R&D partnerships, have a significantly positive effect on overall firm performance (Frohlich and Westbrook, 2001; Rosenzweig *et al.*, 2003). This provides further empirical support for a seminal study by Hagedoorn (2002). Studying the trend in R&D partnerships over the past four decades, Hagedoorn has found that joint ventures have become less popular due to organizational costs and a high failure rate. By contrast, the number of R&D partnerships has increased markedly, especially in high-tech industries. This study provides empirical evidence to suggest that R&D partnerships are of central importance to high-tech SMEs in the context of SCM, providing a rigorous solution to the very important and challenging problem of finding a good fit between SMEs and SCM. The results of this study show that SMEs can benefit from certain types of supply chain partnerships (R&D partnerships), but not from partnerships in all functional areas. Here we summarize our understanding of the problem “SCM-SME fit” using our findings and previous studies.

SMEs suffer from a lack of resources. Thus they try to gain competitive advantage from their supply chain partnerships. However, developing a partnership itself requires certain specific resources many of which are not present within SMEs, hence building competitive advantage
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from partnerships is difficult.

Relying on above statement for SMEs, we draw the following conclusion for high-tech SMEs:

High-tech SMEs suffer from lack of resources in general and not in R&D, but in the R&D functional area they are often able to develop competitive advantage from their R&D partnerships.

Managerial implications

The results from this study present a number of implications for firms. For firms trying to build relations and partnerships, influencing organization-wide aspects, such as trust and commitment, is a difficult long-term process. The functional view, however, allows senior managers to assess which particular functions depend most on, or are relatively best at, partnerships with their supply chain partners. Furthermore, the effect that the degree of partnership has on overall firm performance can be assessed by identifying where the partnership efforts pay off and where they do not. Our results confirm the importance of strategic partnership, but indicate that it is at the functional level where these should be created and developed. Furthermore, individual functions can, and should, vary in their degree of dependence on such partnerships, because the effect of these partnerships on firm performance is different for each function. Indeed, our results indicate that high-tech SMEs should focus on partnerships in the area of R&D to improve their performance.

Future research

We have investigated strategic partnerships for SMEs in specific industries. Further research is now required to extend our type of analysis to include other industries and other types of companies, for example, low-tech instead of high-tech companies. It has been extensively argued

in the literature that SMEs play a key role in both developed and developing economies (Garengo and Sharma, 2014; Panizzolo *et al.*, 2012), however it is not clear if there are differences between the engagement of SMEs in partnership and their performance in developed and developing countries which is an interesting future research agenda. In existing literature, multi-criteria decision-making methods have been used to measure performance of SMEs (see, for example, Sharma and Sharma, 2010; Bhagwat and Sharma, 2009; Sharma and Bhagwat, 2007). Future research could apply these multi-criteria decision-making methods to measure supply chain partnerships for different functional areas, and investigate the relationship between SMEs engagement in supply chain partnerships and their performance. This research has shown how using a functional perspective in studying supply chain partnerships can provide insight into their performance. A direct consequence of the functional model used is to assess the performance per function in a firm.

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