



Paper to be presented at the DRUID Academy conference in Rebild, Aalborg, Denmark on January

15-17, 2014

## **A helping hand - Enhancing the knowledge base of SMEs**

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### **Abstract**

Title: A helping hand ? Enhancing the knowledge base of SMEs

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Year of enrolment: 2012

Excepted final date: October 31, 2015

### **Introduction**

The objective of this paper is to analyze the interaction between firms and external actors in Denmark, primarily the firms' collaborations with a selected group of four external actors, including 1) GTS-institutes (i.e. approved technological institutes), 2) universities/higher education institutions (i.e. HEI), 3) private R&D-firms (i.e. consultants, private laboratories and research institutions), and 4) public research institutions. For the purposes of this paper, those four types of actors are termed external scientific actors and constitute knowledge institutions. The analysis is executed with a firm's perspective; thus, the use of 'external actor' illustrates the focal point of the firms. Furthermore, a special focus is given to innovation and collaborations between the small and medium-sized enterprises (SMEs) and the selected group of external scientific actors in the Danish innovation system.

### **Research gap**

The existing literature states small and medium-sized enterprises (SMEs) lack 'absorptive capacity' and this is a major barrier for SMEs to learn from external sources including the scientific community (Cohen and Levinthal, 1990; Bierly and Daly, 2007). 'Absorptive capacity' is defined as 'the ability to recognize the value of new information, assimilate it, and apply it to commercial ends?', as introduced by Cohen and Levinthal in 1990 (p.128). This concept has been

expanded on, including in the direction of learning processes. As a sub-element to build the firm's capacity, the phases of the learning processes have been described as 'exploration', 'transformation', and 'exploitation' (Lane et al. 2006). Activities related to exploration and exploitation are important to building knowledge (March, 1991), as well as 'transformation' links the exploration and exploitation through internal processes (de Mota Pedrosa, 2013). Newer literature on Open Innovation 'innovation intermediaries' indicate their function as a broker, whose aim at achieving a transaction (Chesbrough 2006) and serve a communication entity between stakeholder in the innovation system (Katz et al. 2013; Howells, 2006). In literature, intermediaries have been identified to have a range of competences and roles, such as matchmaking capabilities, insights into both worlds, and process and interaction coordination. There is a gap in research on the firms' interaction level with intermediaries in enhancing the knowledge base of SMEs.

#### Main theoretical arguments

The first step in increasing the knowledge base of SMEs is that firms gain access to external knowledge sources. Intermediaries are the links to the scientific community and assist in the firms' learning through collaborations. The assumption is that firms learn from collaborating with an external knowledge source. Statistical data highlights the innovative firms' selection of external partners and the type of innovation pursued by the firms.

#### Research methods

For the purposes of this paper, the quantitative methods used are statistics from secondary data. The datasets are extracted from the innovation database of 2010 from Statistics Denmark. The data is purely percentages on frequencies of interactions in terms of number of firms interacting with a selected group of external actors. Seven hypotheses are examined through the statistical data and inferences are made on interaction levels across innovation types.

#### Results and outcomes

Results indicate large firms are more innovative and collaborate more with external scientific actors than SMEs, as well as more innovative SMEs collaborate with intermediaries than the scientific community, suggesting SMEs are relatively 'closer' to intermediaries, which confirms the theoretical conceptualization of the firms' interactions with a selection of external knowledge sources.

# A helping hand – Enhancing the knowledge base of SMEs

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## Abstract

*Firms' innovation collaborations with external scientific actors, i.e. intermediaries and the scientific community are studied in this paper. Statistical data illuminates the interaction level between firms and 'links' and 'cores' of knowledge producing sources. In theory, firms learn by interacting and collaborating with sources of knowledge; the frequencies in terms of number of firms collaborating with external scientific actors is examined to gain an understanding on the innovation collaborations in a Danish context. A special attention is given to SMEs (small and medium-sized enterprises) and their interactions with various types of actors, intermediaries and scientific community. Results indicate large firms are more innovative and collaborate more with external scientific actors than SMEs, as well as more innovative SMEs collaborate with intermediaries than the scientific community, suggesting SMEs are relatively 'closer' to intermediaries, which confirms the theoretical conceptualization of the firms' interactions with a selection of external knowledge sources.*

## What is being investigated?

### *Introduction*

The objective of this paper is to analyze the interaction between firms and external actors in Denmark, primarily the firms' collaborations with a selected group of four external actors, including 1) *GTS-institutes*<sup>1</sup> (i.e. approved technological institutes), 2) *universities/higher education institutions* (i.e. HEI), 3) *private R&D-firms* (i.e. consultants, private laboratories and research institutions), and 4) *public research institutions*. For the purposes of this paper, those four types of actors are termed *external scientific actors* and constitute *knowledge institutions*. The analysis is executed with a firm's perspective; thus, the use of 'external actor' illustrates the focal point of the firms. Furthermore, a special focus is given to *innovation*<sup>2</sup> and *collaborations*

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<sup>1</sup> The objective of the GTS-institutes ('Godkendte Teknologiske Serviceinstitutter') is to create more innovative and competitive Danish firms, which is done through sales of knowledge, technological services, and collaborations with firms – in particular SMEs. There is special need for SMEs to gain access to the latest research-based knowledge. The GTS-institutes focus on development and implementations of new knowledge, including testing, product and process optimization, quality assurance, certifications and benchmarking. (GTS, 2013)

<sup>2</sup> "An *innovation* is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations." (OECD, 2005: p.46)

between the small and medium-sized enterprises (SMEs) and the selected group of external scientific actors in the Danish innovation system.

The underlying assumption of this paper is that firms can enhance their own knowledge base by interacting and collaborating with external actors – especially external scientific actors. Another assumption is that the capacity of an organization – an SME – grows through accumulated learning. By collaborating actively, the firms can draw on knowledge sources external to the firm and interactively learn and innovate together with external actors, more precisely an actor from the scientific community. As stated by Lundvall, assuming that the most fundamental resource in the modern economy is knowledge, then the most important process is learning which is described as predominantly being an interactive and thus a socially embedded process (2010); these are prerequisites for interactive and collaborative innovations. In theory, the essence of the type of collaboration referred to has interactive learning and relations-building attributes. If ideas are conveyed into tangible or organizational outcomes, and commercialized or implemented, then innovation is the outcome of the collaboration – and for many an expected goal of the collaboration. This notion could lead to a discussion as to whether the collaboration in itself is a ‘mean to an end’ (in order to attain a defined goal) or an ‘end in itself’ (relations-, relationship- and trust-building interaction with several but uncertain outcomes). An in-depth discussion is beyond the scope of this paper; however, it is an important point to keep in mind and will therefore be addressed shortly in the discussion section.

In recent years, universities have been pursuing to a certain degree the role and responsibility to be more entrepreneurial, commercialize science and to interact with firms in order for the society to gain from the basic research conducted in the scientific community in the form of innovation. This could be labelled as a science or technology ‘push’ from a relatively small world of science and research to the rest of the business world. However, it may be argued that the forces and impacts are greater with a market or demand ‘pull’ (here, demand is driven by the firm) on the knowledge sources from external actors – external from the point of view of the firm. In a linear visualization of knowledge flow, the core of the circle is the focal force:

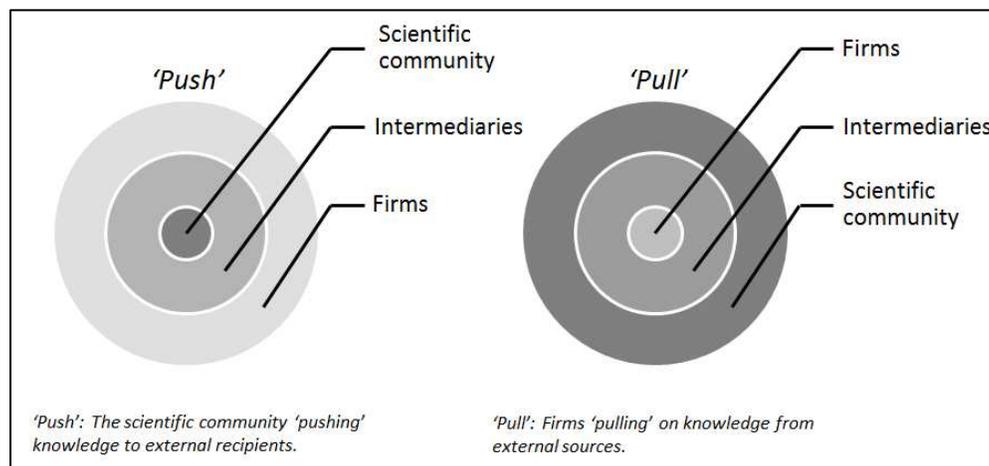


Figure 1. Author's illustration of knowledge flow with the core of the circle being the focal force to 'push' or 'pull' on knowledge.

To distinguish between the external scientific actors in the group of ‘knowledge institutions’, an assumption is that the *core* of basic research is produced in the ‘scientific community’ (i.e. universities and research

institutions) and the *links* between firms and the scientific communities are the ‘intermediaries’ (i.e. GTS-institutes and private R&D-firms/consultants). Thus, the conceptual categorization of the external scientific actors is:

$$\text{Scientific community (core) + intermediaries (links) = knowledge institutions (selected group of external scientific actors)}$$

The intermediaries between firms and scientific community have been established as one of the main mechanism to channel the knowledge produced in the scientific world and spilled over to firms (ERAC, 2012) – or to “bridge” the two worlds (Bessant and Rush, 1995). In the case for Denmark, the GTS-institutes are established as bridge-building institutions. The intermediaries as well as the scientific community are formal institutions producing and transferring knowledge and impacting learning processes of other organizations, including firms (Johnson, 2010). Nonetheless, one of the limitations of this paper is that the intermediary as an independent organization or institution may have its own R&D and contribute to the basic research that is produced in the scientific community; however, to simplify and to signal the closer link to the firms, the intermediaries are assumed to collaborate with the firms on innovation, applied research, technology and knowledge sharing. Thus, in theory the intermediaries are closer to the firms in the innovation collaboration spectrum.

The guiding research question for this analysis is: *do intermediaries give ‘a helping hand’ in enhancing the knowledge base of SMEs?* The hypotheses for the phenomenon of innovation collaborations between firms and scientific community or intermediaries for this paper are:

<i>H1: Innovative firms are in general more process innovative than product, marketing, or organizational innovative.</i>
<i>H2: Large innovative firms are overall more innovative than SMEs, in relative terms.</i>
<i>H3: More large innovative firms collaborate with external scientific actors than is the case for SMEs, in relative terms.</i>
<i>H4: More innovative firms collaborate with intermediaries rather than with the scientific community.</i>
<i>H5: More innovative SMEs collaborate with GTS-institutes than with universities/HEI.</i>
<i>H6: Relationship-building collaborations are more frequent and more valuable to the innovative firm than transaction-based collaborations.</i>
<i>H7: Innovative SMEs collaborate more often on product innovation with knowledge institutions than on other types of innovations.</i>

This paper contributes with results indicating the level of interaction and collaborations between innovative firms<sup>3</sup> of all size and knowledge institutions. The hypotheses are examined through statistics will lay the ground for the qualitative research to the conducted in order to investigate into depth the ‘*why*’ and ‘*how*’ of SMEs collaborate with external scientific actors, such as intermediaries and/or the scientific community. In the following sections the literature with elements adjacent to collaborations is reviewed; then a description of the data is provided followed by a presentation of the results, and finally concluding with discussions.

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<sup>3</sup> “An *innovative firm* is one that has implemented an innovation during the period under review.” (OECD, 2005; p.47)

## **'This' we already know**

### *Literature review*

Firms benefit from collaborating with knowledge institutions, including universities and other research institutes with the underlying argument of knowledge produced from basic research in the scientific community should be transferred into commercial development (Etzkowitz and Leydesdorff, 2000; Turpin et al., 1996). The outcomes of the collaborations with universities generate sales of innovative products and services novel to the market and thereby improving growth performance of firms (Belderbos et al., 2004). Nonetheless, the role of SMEs has been recognized as important 'actors' in creating, applying and introducing innovations in local economies (Curran and Blackburn, 1994). Firms could be developing those together with other actors, as for instance from universities and research institutions to tap into the benefits of collaborations.

Academics have addressed the various barriers constituting a gap or distance between the scientific world and the business world; those are primarily rooted in differences, including language, time horizon, culture, expectations, daily activities, communication styles (Davenport et al., 1999; Iles and Yolles, 2002; Perkmann and Salter, 2012; Tartari et al., 2012). The outcomes of the interactive learning and innovation (Lundvall, 2010) between two different 'worlds' could be significant; however, in order for this to be succeeded, SMEs need to overcome two main barriers, which are the 'not-invented-here' syndrome and the 'lack of absorptive capacity' (Bierly and Daly, 2007). 'Absorptive capacity' was introduced by Cohen and Levinthal (1990) and defined as "the ability to recognize the value of new information, assimilate it, and apply it to commercial ends" (p.128). Cohen and Levinthal also stated that the ability to exploit knowledge is a critical component of innovative capabilities (1990). The concept of absorptive capacity has been expanded on, including in the direction of learning processes. As a sub-element to build the firm's capacity, the phases of the learning processes have been described as 'exploration', 'transformation', and 'exploitation' (Lane et al. 2006). Activities related to exploration and exploitation are important to building knowledge (March, 1991), as well as 'transformation' links the exploration and exploitation through internal processes (de Mota Pedrosa, 2013).

Other authors have proposed that developing and maintaining absorptive capacity increases the firm's knowledge base and enhances the firm's performance (Zahra and George, 2002; de Mota Pedrosa et al., 2013). Organizational performance is linked to the results of yesterday's learning, and the organizational performance of tomorrow will be the product of today's learning (Garcia-Morales et al., 2007). Thus, it may be argued that performance is the execution or accomplishments of activities bound in the level of absorptive capacity, which is the cumulative result of learning. Learning is embedded collaboration process with external actors; knowledge creation or production between two parties is bound to be a learning process.

In the world of businesses, there are also great differences between SMEs and large firms. For instance, large firms have sufficient resources to invest in activities that generate innovations, i.e. R&D, market exploration, and finance collection; whereas, SMEs lack human and financial resources to devote to innovative efforts and practices (Parrilli et al., 2010). SMEs have a stronger need to collaborate because of their lack of internal resources and limited resources for basic research (Katzy et al. 2013). Moreover, SMEs innovate differently than large firms and generally face more uncertainties and barriers to innovation (Roxas et al., 2011). However,

an interesting finding indicates that SMEs learn more from external sources, such as scientific communities, than large but on the other hand, large firms learn more from partnerships and consultants (Bierly and Daly, 2007).

Tying the world of science with the core of basic research to the practical world of firms into one confined 'space', such as when two parties collaborate, then a link between the two worlds, which from a firm's perspective is a 'closer' collaborator for the SMEs than the scientific community. Those links are referred to as intermediaries in this paper. The term 'intermediary' has been examined in different contexts and the roles and functions of the intermediaries have been identified as performing a variety of tasks within the innovation process (Howells, 2006) and having a main function of a consultancy service helping "bridge the gap between technological opportunity and user needs" (Bessant and Rush, 1995; 101). The 'innovation intermediaries', as conveyed by Chesbrough (2006) may function as a broker, whose aim is to achieve a transaction; and, as a communication entity between stakeholder in the innovation system (Katz et al. 2013; Howells, 2006). In theory, the intermediary would *intermediate* the processes between the two worlds and assist the SME in the stages of exploration, transformation, and exploitation of new knowledge from the external sources.

*Re-occurring* collaborations that substantiate relationship- and trust-building aspects are important for the learning processes and the enhancement of the SMEs knowledge base; the ability of a firm to learn from external sources is dependent on the firm's prior knowledge related to these sources (Cohen and Levinthal, 1990). More academics share the perspective on the importance of relationships, ties and trust in collaborations between firms and the scientific community (Davenport et al., 1999; Tartari et al., 2012; Zucker et al., 2002).

### **These are the tools: methods and data**

For the purposes of this paper, the quantitative methods used are statistics from secondary data. The datasets are extracted from the innovation database of 2010 from *Statistics Denmark* collecting data with a questionnaire sent out to thousands of Danish firms on a yearly basis (Statistics Denmark, 2013). The intended aim of the statistics is to illustrate the scope, nature, and impact of Danish businesses innovation (Ibid). The results in this paper reflect the firms responding on their innovations and activities in the years of 2008, 2009, and 2010. In total 19,483 firms responded to the innovation survey. 9,188 firms indicated being 'innovative firms', as the firms have been active with innovation by introducing one or more of the following four types of innovations: products (good and services), processes, marketing, and/or organizational.

The data has been analyzed in two parts. The first part of the data was readily available online at Statistics Denmark; this dataset represents frequencies on all the responses on the innovation survey 2008-2010. The various frequencies are calculated to percentages for the purposes of the statistics. The data is based on innovative firms (N=9188) and all four types of innovation.

Collaborations according to firm size and industries are represented in tables to give an overview of the overall interactions and collaborations for innovation in Denmark. However, the particular outcome of the collaborations cannot be inferred with great certainty from those statistics. Sources of uncertainties include the

firms' ability to distinguish between the various types of innovations, insecurity in determining when an innovation is an innovation, or identifying innovation collaborations or activities undertaken in the firm in the period under review.

The second part of the analysis was extracted from the innovation database at Statistics Denmark and results were given via the SAS system in the format of 'FREQ Procedure' with weighted frequencies and percentages. This data is only on SMEs (N=8775); Statistics Denmark defines an SME in regards to the number of employees – firms with fewer than 250 – as stated in Article 2 of the ANNEX in the EU recommendation 2003/361. The reasoning behind attaining data on SMEs solely is that the further research to be conducted is qualitative studies with SMEs only, as well as to achieve a macro-level overview of the collaboration between SMEs and knowledge institutions since the majority of best practices and case studies originate from universities collaborating with large firms and corporations with capabilities and absorptive capacity which SMEs do not have. Therefore, firm size in terms of employees is of special importance to this part of the data analysis. Furthermore, the data from the SAS output is more detailed and profound than the dataset and frequencies attained from Statistics Denmark. The focus is on three types of innovations – product, process, and organizational – and a selected group of four external actors were chosen for this paper, as presented in the introduction, constituting the group of 'external scientific actors': 1) *GTS-institutes* (i.e. approved technological institutes); 2) *universities/higher education institutions* (i.e. HEI); 3) *private R&D-firms* (i.e. consultants, private laboratories and research institutions); and, 4) *public research institutions*. Indicator variables, or dummy variables, were created for 'collaboration with GTS-institutes', 'collaboration with University/HEI', 'collaboration with Private R&D-firms', and 'collaboration with Public research institutions' (i.e. *samviden*) cross-sectioned with variables including 'primary developer of new products' and 'introduced new services'. Also, two new variables were created (i.e. *samviden\_more*): One variable to indicate whether the SME has collaborated with at least one of the external scientific actors; and the second variable as an extension of the previous variable, which indicates how many of the external scientific actors the SME has collaborated with.

There are some limitations to the data that make the inferences rather restrictive and merely guiding. Firstly, the combined group of universities and higher education institutions (HEIs) as an option for the firms to respond in the questionnaire is a limitation. Assuming the universities are the *core* in the production of basic research and many of the HEIs not having their own R&D and therefore not part of the scientific community per se, then it is difficult to conclude on the collaboration between SMEs and the sole actor of the scientific community, i.e. universities. This limitation is approximated by an indicated variable (i.e. *innomore*) for SMEs collaborating with an *X* amount of universities, up to a total of five out of all 8 universities in Denmark. These numbers are then compared to the overall numbers to determine the split between Universities and HEI. Secondly, the definition of intermediaries, for the purposes of this paper, is determined to be a *link*; however, the intermediary may have its own R&D as an independent organization or institution and thereby contribute to the basic research that is produced in the scientific community. Assuming the intermediary is merely a *link* with a focus on applied research 'reduces', for the purposes of this paper, the role and function of an intermediary as a channel and not a direct generator of basic research. Thirdly, consultants may be a better representative of the term 'intermediaries' than private R&D-firms which may contribute with some basic research, and therefore separated options on the questionnaire would have been preferred; however, for the research objectives of this paper the assumption is that the consultants as well as private R&D-firms are *links* and contributing to the applied research in the system of R&D&I.

## Who gives a 'helping hand'?

### *Innovation collaborations*

In this section of the paper, the statistics are presented in tables with percentages illustrating the level of interaction and collaborations between firms and knowledge institutions. The statistics are mainly reported from the firms' perspective and focuses on collaborations with external scientific actors (intermediaries and scientific community), types of innovations introduced and implemented, and the firm as a primary developer of products or processes in collaboration with a knowledge institution.

The terms 'collaboration' and 'interaction' are used interchangeably in this section and refers to a more descriptive type – 'innovation collaborations' – by including 'innovation' in the terminology. As defined by Statistics Denmark,

*'Innovation collaboration' includes active participation in innovation activities with other firms, universities and other research institutions. The collaboration must not result in immediate commercial benefits for both parties. Pure outsourcing of innovation activities, which do not involve active cooperation, is not included.*

A special attention is given to firm size and the distinction between firms collaborating with intermediaries (i.e. GTS-institute and private R&D-firms/consultants) and/or the scientific community (i.e. university and public research institutions).

### *Results for innovative firms*

This part of the section examines the data attained on innovative firms of all sizes (*Tables 1-6*), followed by the second dataset on innovative SMEs in the next part (*Tables 7-15*). The first hypothesis is based on the notion that process innovations can decrease unit costs of production/delivery or increase quality (OECD, 2005). *Table 1* shows the percentages of firms indicating themselves as being product, process, marketing, and/or organizational innovative firm.

*Hypothesis 1: Innovative firms are in general more process innovative than product, marketing, or organizational innovative.*

As seen in *Table 1*, most micro-firms indicate being marketing innovative firms, whereas small, medium-sized, and large firms are organizational innovative; thus, in relative terms, by sub-group for each firm size, 62.3 percent of small firms have introduced or implemented new organizational methods in the years 2008 to 2010. Therefore, it appears that *H1* is false.

Table 1. Innovative firms indicating the type of innovation actively introduced or implemented in the time period 2008-2010: product (goods/services), process, marketing, and/or organizational innovation.\*

	Firm size (number of employees)			
	Micro-firm (< 10)	Small firm (10-49)	Medium firm (50-249)	Large firm (250+)
Product Innovative firm	50.6 %	46.0 %	43.0 %	56.5 %
Process Innovative firm	54.4 %	51.3 %	53.6 %	66.7 %
Marketing Innovative firm	58.5 %	52.5 %	51.7 %	62.0 %
Organizational Innovative firm	54.5 %	62.3 %	70.5 %	78.4 %
<i>Innovative firms (Total, N=9188)</i>	<i>Sub-group N=3598</i>	<i>Sub-group N=3716</i>	<i>Sub-group N=1490</i>	<i>Sub-group N=384</i>

Source: Statistics Denmark's survey of R&D and innovation 2010.

Base: Innovative firms, N=9188. Note: The numbers represented in the table are relative percentages according to firm size.

\*Firms may be innovative in one or more of the innovation types, therefore the percentages are above 100 percent in each column (product innovative N=4388, process innovative N=4920, marketing innovative N=5064, and organizational innovative N=5628).

*Hypothesis 2: Large innovative firms are overall more innovative than SMEs, in relative terms.*

In *Table 1*, large firms with 250 or more employees are relatively more innovative overall, across the four types of innovations introduced in the three year period from 2008 to 2010, than SMEs (i.e. micro-firm, small firm, and medium firm). The percentages in each column is calculated within the group; 78.4 percent of large firms (N=384) responded having implemented new methods for organizational innovation, including workplace organization, business practices, and external relations. Large innovative firms have overall higher relative percentages than the other three sub-groups for micro-, small and medium firm. *H2* is therefore true, according to those statistics.

*Hypothesis 3: More large innovative firms collaborate with external scientific actors than is the case for SMEs, in relative terms.*

Firms of all sizes collaborate more frequently with private R&D-firms (incl. consultants), as exhibited in *Table 2*. The second most interactive external scientific actors are universities/HEI. The percentages in *Table 2* are out of all innovative firms (N=9188); the highest percentage overall is 4.2 percent, or 385 small firms collaborating with private R&D-firms. Micro-firm collaborating with the same external actor is the second most frequent interaction with 3.9 percent, followed closely by micro-firms and university/HEI, 3.8 percent.

Table 2. Innovative firms collaborating with external scientific actors – out of all innovative firms.

	Firms size (number of employees)			
	Micro-firm (< 10)	Small firm (10-49)	Medium firm (50-249)	Large firm (250+)
GTS-institute	1.4 %	2.2 %	0.96 %	0.65%
University/HEI	<b>3.8 %</b>	2.7 %	1.9 %	1.2 %
Private R&D-firm	<b>3.9 %</b>	<b>4.2 %</b>	<b>2.3 %</b>	<b>1.5 %</b>
Public research institution	1.7 %	1.6 %	0.82 %	0.65 %

Source: Statistics Denmark's survey of R&D and innovation 2010.

Base: Innovative firms, N=9188.

The same 'trend' is illustrated in *Table 3*. 3150 innovative firms out of 9188 innovative firms have indicated having innovation collaboration with an external actor – in total, 34.3 percent. Out of those 34.3 percent, for instance 6.3 percent are small firms collaborating with GTS-institutes. Note, one firm may have collaborations with more than one of the four external actors in *Table 3*. Other external actors the firms could be collaborating with are but not included in the table: suppliers; customers; competitors or other firms in the same industry; firms in other industries (exclusive suppliers/customers); public service providers; and other public partners.

To investigate whether large firms collaborate relatively more with knowledge institutions than SMEs do, *Table 4* gives an overview of this situation. Percentages are calculated within sub-groups for innovative firms responding having collaborated on innovation with an external actor in the years 2008-2010 ( $N=3150$ ). The percentages in the column to the right – large innovative firms – are higher than the percentages in the other columns for SMEs. Therefore, large firms are relatively more active in collaboration with knowledge institutions than smaller firms – *H3 is true*. This table also confirms the interaction level with private R&D-firms/consultants as the highest within each sub-group, as *Table 2 and Table 3* showed as well.

Table 3. Innovative firms collaborating with external scientific actors – indicating having an external partners (N=3150).

	Firms size (number of employees)			
	Micro-firm (< 10)	Small firm (10-49)	Medium firm (50-249)	Large firm (250+)
GTS-institute	4.0 %	6.3 %	2.8 %	1.9 %
University/HEI	11.2 %	8.0 %	5.4 %	3.6 %
Private R&D-firm	<b>11.4 %</b>	<b>12.2 %</b>	<b>6.6 %</b>	<b>4.4 %</b>
Public research institution	5.0 %	4.5 %	2.4 %	1.9 %

Source: Statistics Denmark's survey of R&D and innovation 2010.

Base: Innovative firms with external partners, N=3150.

Table 4. Innovative firms indicated having collaborated with an external partner. The numbers represented in the table are relative percentages according to firm size for the selection of external scientific actors (for firms collaborating with an external actor).

	Firms size (number of employees)			
	Micro-firm (< 10)	Small firm (10-49)	Medium firm (50-249)	Large firm (250+)
GTS-institute	10.2 %**	16.9 %	16.3 %	<b>27.3 %</b>
University/HEI	28.8 %	21.6 %	31.5 %	<b>51.4 %</b>
Private R&D-firm	<b>29.5 %</b>	<b>32.9 %</b>	<b>38.3 %</b>	<b>63.7 %</b>
Public research institution	12.9 %	12.2 %	13.9 %	<b>27.3 %</b>
<i>Innovative firms with external actors (N=3150)</i>	<i>Sub-group N=1221</i>	<i>Sub-group N=1169</i>	<i>Sub-group N=540</i>	<i>Sub-group N=220</i>

Source: Statistics Denmark's survey of R&D and innovation 2010.

Base: Innovative firms collaborating with an external actor, N=3150.

Note: A firm may have collaborated with one or more of the external scientific actors; therefore the percentage may be less or above 100 percent.

\*\* An example: SMEs with less than 10 employees collaborating with a GTS-institute is 125 innovative firms out of a total of 1221 innovative firms indicating having collaborated with an external actor in the years 2008-2010 which in total are 10.2 percent of innovative firms with external partners.

Table 5. The selected four types of external scientific actors collaborating with innovative firms – by number of collaborations with firms.

	GTS-institute	University/ HEI	Private R&D-firm	Public research institution
Micro-firm (< 10)	26.6 %	<b>39.6 %</b>	<b>33.0 %</b>	<b>36.1 %</b>
Small firm (10-49)	<b>42.1 %</b>	28.4 %	28.4 %	32.9 %
Medium firm (50-249)	18.7 %	19.1 %	19.1 %	17.2 %
Large firm (250+)	12.8 %	12.7 %	12.7 %	13.8 %
<i>Collaborations (N=2885)</i>	<i>Sub-group N=470</i>	<i>Sub-group N=888</i>	<i>Sub-group N=1092</i>	<i>Sub-group N=435</i>

Source: Statistics Denmark's survey of R&D and innovation 2010.

Base: Knowledge institutions collaborating with firms, N=2885. Note: The percentages are stated from the external scientific actor's perspective collaborating with different firm sizes (employees).

*Hypothesis 4: More innovative firms collaborate with intermediaries rather than with the scientific community.*

*Hypothesis 4* can be verified by a range of statistics in *Tables 2, 3, 4, and 6*. *Table 2* with the overall interaction level, as well as *Table 3* with collaboration among firms with external partners, both tables indicate more firms collaborating with intermediaries. Not presented in the tables, 17 percent<sup>4</sup> of firms interact with intermediaries (GTS-institute and Private R&D-firms), whereas 14.4 percent<sup>5</sup> collaborate with the scientific community (University/HEI and Public research institutions). The trend is the same in *Table 3*, though with higher percentages, as the *N* is all innovative firms with external partners (*N*=3150). *Table 4* exhibits the interaction level for each sub-group and states that the highest percentage in each sub-group is collaborations with private R&D-firms/consultants; for example, 38.3 percent of medium firms (*N*=540) interact with this type of external actor. Thus, it may be argued that the ‘preferred choice’ for each type of firm size is collaborations with consultants/private R&D-firms. However, though the percentages favor intermediaries overall, universities/HEI is the second most common interaction-partner(s) out of the four external scientific actors. An interesting fact is that the percentages of firms interaction with GTS-institutes compared to private R&D-firms and university/HEI are low, which may be a surprising factors, as the GTS-institutes were established as *bridging mechanisms* between the scientific community and firms.

A knowledge institution perspective is taken in *Table 5*. This table shows the division of interaction of each institution with the range of firm sizes. As an example, the group of University/HEI has 888 collaborations with various sizes of firms; 39.6 percent of the 888 are micro-firms, 28.4 percent are small firms, 19.1 percent are medium firms, and 12.7 percent are large firms. Overall university/HEI, private R&D-firms, and public research institutions collaborate mostly with micro-firms, whereas GTS-institutes have an overall high with 42.1 percent with small firms (10-49 employees). One may interpret this as micro-firms prefer collaborating with those three types of external scientific actors, and small firms prefer GTS-institutes; however, this is not true. *Table 4* represents the percentages for each firm size category and here it is evident – across firm sizes – the majority collaborate with private R&D-firms, and university/HEI as second most frequent partner.

To be noted, in *Table 5* is it not evident what type of collaboration is it and its magnitude or value; the statistics do not convey this information. The percentages only confirm the overall structure of the business world with a great majority of micro-firm with 85.4 percent, and the reflects the rest of the business environment with small firms 11.9 percent, medium-sized firms 2.4 percent, large firms 0.4 percent, and SMEs with an overall 99.6 percent<sup>6</sup>. GTS-institute interacting mostly with small firms is the exception – this is also visible in *Table 2* with 2.2 percent and in *Table 3* with 6.3 percent for ‘small firms and GTS-institute’ collaborations. Nonetheless, more representative percentages of the interactions in relative terms are illustrated in *Table 4*.

*Table 6* with the depiction of industry sub-groups interactions with the four external scientific actors (for those with external partners, *N*=3150), the majority of firms – regardless of industry – collaborate mostly with private R&D-firms and university/HEI as second choice. What is not included in *Table 6* is the percentages of innovative firms with external partners (*N*=3150) out of all 9188 innovative firms; at least approximately 28 percent of innovative firms have external partners, with ‘financing and insurance’ having the highest relative percentage,

<sup>4</sup> 407 interactions with GTS-institute and 1092 interactions with Private R&D-firms out of all 9188 innovative forms, is 17 percent.

<sup>5</sup> 888 collaborations with University/HEI and 435 with Public research institutions, which is 14.4 percent out all 9188 innovative firms.

<sup>6</sup> European Commission (2012), Enterprise and industry: SBA Fact Sheet 2012 – Denmark. Accessed December:

[http://ec.europa.eu/enterprise/policies/sme/facts-figures-analysis/performance-review/files/countries-sheets/2012/denmark\\_en.pdf](http://ec.europa.eu/enterprise/policies/sme/facts-figures-analysis/performance-review/files/countries-sheets/2012/denmark_en.pdf)

42.1 percent<sup>7</sup>, and lowest relative percentage is ‘commerce’ with 28.7 percent<sup>8</sup>. The number of firms in each industry sub-group is provided in *Table 6* in the last column – ‘business services’ and the ‘industrial sector’ with the overall most firms with external partners. However, to be noted is the high percentages of collaborations between firms in the sub-groups of ‘construction industry’ (25.0 percent) and the ‘industrial sector’ (23.6 percent) with GTS-institutes, compared to the other percentages in the column for GTS-institutes. Thus, overall *H4* is true.

Table 6. Innovative firms collaborating with an external actor – by industry sub-group and selected type of actors (i.e. external scientific actors).

	GTS-institute	University/HEI	Private R&D-firm	Public research institution	Sub-group (N=)
Industrial sector	23.6 %	30.4 %	<b>40.2 %</b>	16.7 %	<b>826</b>
Construction industry	<b>25.0 %</b>	21.4 %	<b>25.0 %</b>	7.1 %	28
Commerce	9.7 %	15.0 %	<b>36.3 %</b>	5.8 %	586
Transport	5.9 %	20.6 %	<b>50.0 %</b>	14.7 %	34
Hotel/Hospitality	0.0 %	18.8 %	<b>31.3 %</b>	0.0 %	32
Information & Comm.	9.5 %	22.3 %	<b>25.8 %</b>	9.5 %	601
Financing and insurance	7.0 %	20.0 %	<b>50.4 %</b>	10.4 %	115
Business services	13.9 %	<b>39.1 %</b>	31.4 %	19.5 %	<b>856</b>
Other industries	34 %	<b>52.1 %</b>	48.8 %	24.7 %	73

Source: Statistics Denmark’s survey of R&D and innovation 2010.

Base: Innovative firms collaborating with an external actor, N=3150. Note: highest percentages/numbers are in bold and second highest in italics.

Note: A firm in an industry may have collaborated with one or more of the external scientific actors or have collaborated with other external actors not displayed in the table; therefore the percentage may be less or above 100 percent.

### Results for innovative SMEs

In this part of the section the statistics refers to the datasets on innovative SMEs; therefore, ‘innovative SME’ and solely ‘SME’ is used interchangeably but the results reflect the group of innovative SME (N=8775). In the case for innovative SMEs, a majority of innovative SMEs collaborate with intermediaries rather than the scientific community, as was the case with innovative firms overall. As depicted in *Table 7*, 14.1 percent of interactions are between innovative SMEs and intermediaries, whereas 11.7 percent are innovative SMEs-scientific community collaborations. It is evident that innovative SMEs interacts more with private R&D-firms – 9.42 percent – and secondly with university/HEI 7.98 percent. Overall, innovative SMEs interact more with intermediaries than will the scientific community; this restates the findings for *H4*.

Table 7. Innovative SMEs collaborating with the selected group of external scientific actors.

	GTS-institute	University/HEI	Private R&D-firm	Public research institution
Innovative SMEs	4.68 %	7.98 %	9.42 %	3.71 %

Source: Statistics Denmark’s survey of R&D and innovation 2010. Base: Innovative SMEs, N=8775.

<sup>7</sup> 115 firms in the financing and insurance industry have external partners out of 273 innovative firms in that particular industry.

<sup>8</sup> 586 firms in ‘commerce’ collaborate with an external actor on innovation out of 2045 innovative firms in the industry of commerce.

*Hypothesis 5: More innovative SMEs collaborate with GTS-institutes than with universities/HEI.*

Addressing *H5*, it can be stated that innovative SMEs tend to collaborate more with universities/HEI – 7.98 percent – than with GTS-institutes, 4.68 percent. *Tables 7, 10 and 14* show this fact, as well as the percentages in *Tables 2, 3 and 4* for innovative firms of all sizes; therefore, *H5* is false.

In *Table 8* it can be seen that 15.6 percent of SMEs collaborate with *at least one* of the four external scientific actors. The amount of SMEs interacting with two or more of the external scientific actors decreases with more partners. For instance, 9.3 percent of SMEs collaborated with one knowledge institution and 3.7 percent with two of the knowledge institutions or external scientific actors, and so forth.

Table 8. Innovative SMEs collaborating with one or more of the selected group of external scientific actors in the time period 2008-2010.

	<b>Collaborated with <i>at least one</i> of the scientific external actors</b>	Collaborated with <i>one</i> of the scientific external actors	Collaborated with <i>two</i> of the scientific external actors	Collaborated with <i>three</i> of the scientific external actors	Collaborated with <i>all four</i> scientific external actors
Innovative SMEs	<b>15.6 %*</b>	9.3 %	3.7 %	1.4 %	1.2 %

Source: Statistics Denmark's survey of R&D and innovation 2010.

Base: Innovative SMEs, N=8775. \*84.4% have not collaborated with any of the four types of external actors.

*Hypothesis 6: Relationship-building collaborations are more frequent and more valuable to the innovative firm than transaction-based collaborations.*

Addressing *H6*, there are no direct observations on the relationship-building factors of collaborations as only the number of interactions between a firm and a range of external scientific actors are available in the dataset. *Table 8* only conveys the level of interactions but not, for example, how often one firm has collaborated with the same partner during the time period 2008-2010. Collaborating with more external partners at once cannot be confirmed as either relationship-building or transaction-based since there are no indications for the nature of these collaborations. In other words, if one firm collaborated with three different external scientific actors, it does not imply that those are merely transaction-based but perhaps more *relations*-building. In theory, the more effective the collaboration with a particular partner is, the greater impact and positive effects of the outcome(s) of the collaborations are. Thus theoretically speaking, relationship-building interactions should be more valuable to the firm than transaction-based collaborations. It is therefore suggested that the questionnaires in the future would include questions on the interaction frequency with particular external actor to determine the relationship-building factors of collaborations. Therefore, *H6* cannot be verified in the statistical dataset.

An important point is that the statistical dataset on the interaction levels categorized by *firm size* and the four *scientific external actors*, as well as the *firm innovation type*, do not convey whether the actual outcome (i.e. innovation) is a result of the collaboration with a knowledge institution. It merely depicts the firms' innovation activity according to the four types of innovation and which external partners the firms had in the years of 2008-2010. In order to identify whether the particular innovation was a result of the collaboration – or to get

as close as possible to infer whether this hold true – a cross-section between the variables where the innovative SMEs answer who is the primary developer of the introduced product or process, ‘the firm in collaboration with others’, and the variable indicating having collaborated with one or more of the four external scientific partners. This would give a better indication, but not certainty, whether the firm as a result of the collaboration was innovative for the time period. However, it is uncertain whether the firm was innovative with a different partner not captured in the statistics, and at the same time had collaborated with a knowledge institution on a non-implemented innovation that was still in process at the time of the survey. Nonetheless, *Tables 9-12* are indicating these outcomes, though the percentages for primary developers of products and processes in collaboration with external partners are difficult to compare directly since there is a limitation with a number of missing values for each of the two (*missing values; N=4597 for products, and N=4123 for processes*).

*Hypothesis 7: Innovative SMEs collaborate more often on product innovation with knowledge institutions than on other types of innovations.*

*Tables 9-12* are considered as the most approximate estimates to determining whether *hypothesis 5* is true or false. Caution is taken on concluding due to the irregularities of the *N* sizes of the two variables for products (i.e. goods and services) and processes. *Table 9* shows that 31.0 percent of innovative SMEs responded being the primary developer of new products in collaboration others and having collaborated with an external partner (*N=4179*) in the same time period. Whereas 39.1 percent of innovative SMEs indicated being the primary developer of processes in collaboration with others and having collaborated with external partners (*N=4652*). This could indicate a relative higher percentage of SMEs collaborating on developing new process with external actors.

Table 9. Innovative SME as primary developer of new products/processes with others and collaborating with external actors.

	Primary developer of <i>new products</i> in collaboration with external actors	Primary developer of <i>new processes</i> in collaboration with external actors
Innovative SMEs	31.0 %*	39.1 %**

Source: Statistics Denmark’s survey of R&D and innovation 2010.

Base: \*Innovative SMEs, N=4179; missing values, N=4596. \*\*Innovative SMEs, N=4652; missing values, N=4123.

In *Table 10* it is rather difficult to determine whether SMEs collaborate more on product or process innovation since the percentages are very similar and *N* varies for the two variables. However, the table illustrates the type of partners that the firms ‘prefer’ or have collaborated with on the two types of innovations; as was the case in previous tables, firms as well as SMEs (in *table 10*) interact more with private R&D-firms on both products and processes, and universities/HEI as the second choice. An interesting fact is that more SMEs have collaborated and most likely developed products/processes with universities/HEIs than with GTS-institutes and been – this is the case for both products (4.8 percent vs. 2.7 percent) and processes (5.1 percent vs. 2.6 percent). Also, it appears that SMEs prefer to collaborate with universities/HEI and private R&D-firms over GTS-institutes (*H5*).

Table 10. Innovative SMEs as primary developers of products/processes in collaboration with others and collaborating with the selected group of external scientific actors.

	GTS-institute	University/ HEI	Private R&D-firm	Public research institution
<i>Innovative SMEs as primary developers of new:</i>				
Products*	2.7 %	4.8 %	5.4 %	2.9 %
Processes**	2.6 %	5.1 %	6.8 %	2.3 %

Source: Statistics Denmark's survey of R&D and innovation 2010. Note: Products is both goods and services.

Base: \*Innovative SMEs, N=4179; missing values, N=4596. \*\*Innovative SMEs, N=4652; missing values, N=4123.

As mentioned in the methods and data section, there is a limitation to the grouping of universities and HEIs into one answering option in the survey. *Table 11* represents the percentages of SMEs collaborating with *at least one university* on and developing products and processes with an external actor – 4.66 percent and 4.60 percent, respectively. However, in order to investigate the split between universities and HEI, the row of interest *Table 11* is SMEs collaborating with *one* university compared to the percentages in for the combined group 'University/HEI': 2.58 percent (*Table 11*) or 108 firms collaborated with one university and indicated being primary developer of the new products with others (N=4179), whereas the combined group 'university/HEI' had 4.8 percent or 202 firms (*Table 10* and N=4179). Subtracting 108 firms with university-collaborations from a total of 202 firm-university/HEI-collaborations, then 94 are firm-HEI collaborations. In other words, the division in *Table 10* is 53.5 percent SMEs collaborating with universities and 45.5 percent with HEI. Also, in the case for 'processes': 58.4 percent are firm-university and 41.6 percent are firm-HEI<sup>9</sup>.

It cannot be stated whether SMEs collaborate with knowledge institutions more on product than processes, but what can be stated in the isolated case for universities vs. HEI, though with some uncertainty, which indicates that SMEs collaborate more with universities than HEI on both products and processes. Nonetheless, in *Table 11* it can be stated that most SMEs collaborate with universities and being the primary developer of – for instance products – have an interaction with *one* university in most cases, with 107 SMEs out 4179 (or 2.58 percent), and those collaborating with *two* universities in the same time period are nearly 39 SMEs (or 0.93 percent). In this survey, only approximately 2 SMEs out of 4179 interacted with *five* universities and developing products with external actors.

Finally, to be noticed is that 31 percent of innovative SMEs have developed products in collaboration with an external partner (*all types of partners*, N=4179) and 4.66 percent have chosen to collaborate with *at least one* university; whereas, 39.1 percent have developed processes in collaboration with an external partner (*all types of partners*, N=4652) and 4.60 percent have chosen to have *at least one* university as their external partner.

<sup>9</sup> For SMEs as primary developers of processes in collaboration with others and collaborating with university/HEI, 139 firms collaborated with universities and 238 with university/HEI, the 99 firms have collaborated with HEI.

Table 11. Innovative SMEs as primary developers of products/processes in collaboration with one or more universities.

	<i>Innovative SMEs as primary developers of new...</i>	
	Products*	Processes**
<i>... in collaboration with:</i>		
<b><i>at least one</i></b> university	<b>4.66 %</b>	<b>4.60 %</b>
one universities	2.58 %	2.98 %
two universities	0.93 %	0.77 %
three universities	0.76 %	0.70 %
four universities	0.33 %	0.05 %
five universities	0.06 %	0.10 %

Source: Statistics Denmark's survey of R&D and innovation 2010.

Base: \*Innovative SMEs, N=4179; missing values, N=4596.

\*\*Innovative SMEs, N=4652; missing values, N=4123.

Table 12. Innovative SMEs as primary developers of products/processes in collaboration with others and collaborating with one or more of the external scientific actors.

	<i>Innovative SMEs as primary developers of new...</i>	
	Products*	Processes**
<i>... in collaboration with:</i>		
<b><i>at least one</i></b> of the four external scientific actors	<b>9.6 %</b>	<b>10.0 %</b>
one of the external scientific actors	4.9 %	5.7 %
two of the external scientific actors	3.6 %	2.6 %
three of the external scientific actors	0.5 %	1.0 %
all four external scientific actors	0.6 %	0.7 %

Source: Statistics Denmark's survey of R&D and innovation 2010.

Note: Products are both goods and services.

Base: \*Innovative SMEs, N=4179; missing values, N=4596.

\*\*Innovative SMEs, N=4652; missing values, N=4123.

In *Table 12*, the percentages for innovative SMEs as primary developers of products vs. processes in collaboration with others and collaborating with one or more of the external scientific actors; if the percentages were directly comparable, then it would appear as if SMEs collaborate more on *processes* than products with knowledge institutions, for *at least one/one/three/all four* of the external scientific actors. The relative percentages are higher for *products* when SMEs collaborate with *two* of the actors.

Moreover, of all innovative SMEs responding to the question on primary developer of new *products* (N=4179), 9.6 percent have collaborated with at least one of the four scientific actors; however, not stated in *Table 12* is those innovative SMEs being the primary developed together with an external partner (*within group*, N=1295) is 30.9 percent of the cases the external partner is a knowledge institution (one of the four). Also, 10 percent of all innovative SMEs are the primary developer of new *processes* in collaboration with an external partner

(N=4652), and 25.6 percent of the innovative SMEs as primary developers in collaboration with external actors have chosen the partner to be a knowledge institution (*within group*, N=1820). Needless to say, the conclusion is that there are no conclusive percentages favoring one type of innovation over the other in *Tables 9-12*, since the two rows cannot be compared directly with one another; however, the percentages for within group of products or processes, there is slight favor toward product innovation.

Furthermore, *Tables 13 and 14* exhibit the percentages of innovative SMEs introducing various types of innovations categorized into three innovation types: products, processes, and organizational. In *Table 13* the overall percentages of innovative SMEs introducing or implementing innovations are presented. Taking the average of the percentages for each type of innovation<sup>10</sup>, then 30.25 percent of the SMEs has introduced product innovations, 28 percent implemented new processes, and 37.33 percent introduced new organizational methods. This suggests that SMEs have been overall more organizational innovative – and this is the same result as for firms in *Table 1*, when addressing *H1*.

*Table 14* presents the percentages of SMEs introducing any of the three types of innovations in the years 2008-2010 and indicating having collaborated with a knowledge institution during the same time period. It is not certain whether the innovations were a result of the particular collaboration, but this gives an indication that SMEs prefer private R&D-firms for *process innovations and organizational innovation* (university/HEI as second choice), whereas it is a tie between university/HEI and private R&D-firms for ‘*goods*’ (i.e. tangible products) with 4.6 percent, and a slight favor for university/HEI when it comes to ‘*services*’. The percentages in bold are the highest value and those in italics are the second highest in *Table 14*.

Table 13. Innovative SMEs introducing various types of innovations in the time period of 2008-2010.

	Innovative SMEs
<i>Introducing new or significantly improved:</i>	
Goods	37.2 %
Services	23.3 %
<i>Introducing new processes:</i>	
Production methods (techniques, equipment and software used)	24.4 %
Delivery methods (logistics, delivery of final products)	19.2 %
Ancillary support activities (purchasing, accounting, maintenance, etc.)	40.4 %
<i>Introducing new organizational methods:</i>	
Workplace organization (responsibility, decision making)	32.8 %
Business practices (routines/procedures)	46.5 %
External relations (organizing relations, new types of collaborations, etc.)	32.7 %

Source: Statistics Denmark’s survey of R&D and innovation 2010.

Base: Innovative SMEs, N=8775.

<sup>10</sup> An example for product innovation: (37.2 % + 23.3 %)/2 = 30.25 percent

Table 14. Innovative SMEs introducing new products/processes/organizational innovations and collaborating with an external scientific actor.

	GTS-institute	University/ HEI	Private R&D-firm	Public research institution
<i>Introducing new or significantly improved:</i>				
Goods	2.9 %	<b>4.6 %</b>	<b>4.6 %</b>	1.9 %
Services	1.6 %	<b>3.4 %</b>	3.2 %	1.5 %
<i>Introducing new processes:</i>				
Production methods (techniques, equipment and software used)	1.6 %	3.3 %	<b>3.5 %</b>	1.0 %
Delivery methods (logistics, delivery of final products)	1.4 %	2.3 %	<b>2.8 %</b>	1.2 %
Ancillary support activities (purchasing, accounting, maintenance, etc.)	2.1 %	3.9 %	<b>5.0 %</b>	1.6 %
<i>Introducing new organizational methods:</i>				
Workplace organization (responsibility, decision making)	1.8 %	3.4 %	<b>4.9 %</b>	2.0 %
Business practices (routines/procedures)	2.8 %	5.0 %	<b>6.1 %</b>	2.6 %
External relations (organizing relations, new types of collaborations, etc.)	2.4 %	4.4 %	<b>4.6 %</b>	2.7 %

Source: Statistics Denmark's survey of R&D and innovation 2010. Base: Innovative SMEs, N=8775.

Table 15 portrays the interaction level of innovative SMEs with knowledge institutions across the three types of innovations. The averages of the three types of innovations in the column for collaborating with *at least one* of the knowledge institutions reveal that 7.43 percent are organizational innovative and collaborated with *at least one* of the external scientific actors, whereas 6.95 percent are product innovative and 5.87 are process innovative. These numbers could indicate that innovative SMEs are more organizational innovative when collaborating with knowledge institutions; however, it is difficult to state that the outcome of the collaboration is organizational innovation.

Overall, *hypothesis 5* is not true, however it cannot be inferred without uncertainty that innovative SMEs more often collaborate on organizational innovation with knowledge institution than product or process innovations. The indications are *not* in favor of innovative SMEs collaborating more often on product innovation with knowledge institutions than on other types of innovations' and therefore *H5* is rejected with a rather great level of uncertainty.

Table 15. Innovative SMEs introducing products/processes/organizational innovations and indicating collaborations with a number of external scientific actors in 2008-2010.

	<b>Collaborated with <i>at least one</i> of the external scientific actors</b>	Collaborated with <i>one</i> of the external scientific actors	Collaborated with <i>two</i> of the external scientific actors	Collaborated with <i>three</i> of the external scientific actors	Collaborated with <i>all four</i> external scientific actors
<i>Introducing new or significantly improved:</i>					
Goods	<b>8.3 %</b>	4.8 %	2.0 %	1.0 %	0.6 %
Services	<b>5.6 %</b>	3.0 %	1.8 %	0.4 %	0.5 %
<i>Introducing new processes:</i>					
Production methods (techniques, equipment, and software used)	<b>5.6 %</b>	3.3 %	1.3 %	0.6 %	0.4 %
Delivery methods (logistic, delivery of final products)	<b>4.2 %</b>	2.3 %	1.0 %	0.4 %	0.6 %
Ancillary support activities (purchasing, accounting, maintenance, etc.)	<b>7.8 %</b>	4.9 %	1.6 %	0.8 %	0.5 %
<i>Introducing new organizational methods:</i>					
Workplace organization (responsibility, decision making)	<b>7.4 %</b>	4.4 %	1.7 %	0.6 %	0.5 %
Business practices (routines/procedures)	<b>9.9 %</b>	5.9 %	2.4 %	0.8 %	<b>0.9 %</b>
External relations (organizing relations, new types of collaborations, etc.)	<b>8.0 %</b>	4.4 %	2.0 %	0.7 %	<b>0.9 %</b>

Source: Statistics Denmark's survey of R&D and innovation 2010. Base: Innovative SMEs, N=8775.

Table 16. Summary of the hypotheses.

	<b>True/False</b>
<i>H1: Innovative firms are in general more process innovative than product, marketing, or organizational innovative.</i>	False
<i>H2: Large innovative firms are overall more innovative than SMEs, in relative terms.</i>	True
<i>H3: More large innovative firms collaborate with external scientific actors than is the case for SMEs, in relative terms.</i>	True
<i>H4: More innovative firms collaborate with intermediaries rather than with the scientific community.</i>	True
<i>H5: More innovative SMEs collaborate with GTS-institutes than with universities/HEI.</i>	False
<i>H6: Relationship-building collaborations are more frequent and more valuable to the innovative firm than transaction-based collaborations.</i>	<i>Untested</i>
<i>H7: Innovative SMEs collaborate more often on product innovation with knowledge institutions than on other types of innovations.</i>	False

## Do intermediaries give ‘a helping hand’ in enhancing the knowledge base of SMEs?

### *Discussions*

Statistics on firms’ innovation collaborations with *external scientific actors* (intermediaries and scientific community), types of innovations introduced and implemented, and the firm as a primary developer of products or processes in collaboration with a knowledge institution is examined in this paper, with a special attention to firm size and the distinction between firms collaborating with *intermediaries* (GTS-institute and private R&D-firms/consultants) and/or the *scientific community* (university and public research institutions).

In the years 2008 to 2010, Danish innovative firms in general are *not* more process innovative, but in fact more firms have implemented organizational methods. Organizational innovation attempts to decrease costs through new and more efficient concepts or internal organization primarily dealing with people at the organization at work (OECD, 2005). This could be a symptom of the international economic and financial crisis. Large innovative firms are overall more innovative than SMEs, as large firms across all four types of innovation are relatively more innovative. Also, more large firms collaborate with external scientific actors (i.e. knowledge institutions) than SMEs. Furthermore, innovative SMEs do not collaborate more often on product innovation with knowledge institutions than on other types of innovations; as a matter of fact, it appears as if SMEs collaborate mostly on organizational innovations, in line with more firms are being organizational innovative. However, this could be a mere reflection of the firms’ response to the crisis and not per se an outcome of the collaborations.

Of all innovative firms, 34.3 percent collaborate with external actors on innovation. Investigating whether more innovative firms prefer collaborating with intermediaries (GTS-institutes and private R&D-firms/consultants) than with the scientific community (universities/HEI and public research institutions), the conclusion is that more firms collaborate with intermediaries. In fact, most firms collaborate with private R&D-firms/consultants and second most with universities/HEI. The ‘bridge-building’ institutions serving as a mechanism for interactions with SMEs (Bessant and Rush, 1995; ERAC, 2012) – GTS-institutes – are not a preferred collaborator for the firms. Thus, the percentages indicate that more firms collaborate with a *link* rather than the *core*, according to the assumptions described in the introduction. Also, there is no difference when considering innovative SMEs; nearly half as many SMEs collaborate with GTS’ than with university/HEI. Examining the division of SMEs collaborating with either universities or HEIs, 53.5 percent (versus 45.5 percent) collaborate with universities on products, and 58.4 percent (versus 41.6 percent) on processes. It appears as universities are the preferred collaborator for innovative SMEs for both products and processes, as compared to HEI.

Regarding *re-occurring* collaborations, the relationship-building as preferred over transaction-based cannot be tested or verified from the statistical datasets. In theory, if interactive learning (Lundvall, 2010) from collaborating with an external actor, specifically a knowledge institution, and viewing innovation collaborations as an ‘end in itself’, then re-occurring collaborations are preferred. The tables conveying the interaction with a number of external actors (with one or more of the external scientific actors) indicate the range of collaborations in terms of *relations*-building from a network perspective. However, collaborations as an ‘end in itself’ could be interpreted as in-depth *relationship*-building, meaning the focus should not be interacting with as many as possible in a given time (*relations*-building), but having re-occurring collaborations with the same

external partner on a long term basis, given the chemistry between the two parties is good. Re-occurring interactions, either *parallel* (i.e. more tasks at once with same partner) or *continuous* (i.e. one task at the time; starting a new task when one finishes) are in theory more *relationship*-building on a personal level rather than *relations*-building in a network perspective. Incorporating questions addressing the theories behind effective collaborations in the review of R&D and innovation in Danish firms would highlight the importance of it and be a subject for future research.

Finally, to answer the question, *do intermediaries give 'a helping hand' in enhancing the knowledge base of SMEs?*: Yes, intermediaries do give a 'helping hand', assuming the intermediaries are linking the knowledge produced from the scientific community – and from the interactive collaboration itself – as well as the firms are absorbing the knowledge and transforming it into their own. What remains unknown is *how* the processes of enhancing the knowledge base of SMEs are achieved.

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