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Olavi Lehtoranta | Nina Rilla | Torsti Loikkanen

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VTT
PL 1000 (Tekniikantie 4 A, Espoo)
02044 VTT
Puh. 020 722 111, faksi 020 722 7001

VTT
PB 1000 (Teknikvägen 4 A, Esbo)
FI-02044 VTT
Tfn +358 20 722 111, telefax +358 20 722 7001

VTT Technical Research Centre of Finland
P.O. Box 1000 (Tekniikantie 4 A, Espoo)
FI-02044 VTT, Finland
Tel. +358 20 722 111, fax +358 20 722 7001

Internationalisation of knowledge and innovation activities in Finnish innovative SMEs

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Abstract

This publication presents the results of a research project on the internationalisation of innovation activities in Finnish SMEs. We claim that understanding of the internationalisation of SMEs' knowledge and innovation (K&I) activities is a complex task requiring a holistic and interdisciplinary approach. Therefore the study consists of three main blocks of research: statistical micro data analysis, sector surveys and a qualitative case study. The study concentrates on five industry sectors: biotechnology, medical devices, metal products, consumer electronics and technical services.

A major premise of this study is that companies rely increasingly on knowledge created outside of them (external knowledge). The growth and competitiveness of companies largely depend on their ability to take advantage of the international arena for innovation. Thus, the ability to absorb, reconfigure and exploit relevant knowledge is increasingly recognised as a key to a company's overall business strategies, especially to its knowledge and innovation activities. Even large multinationals recognise that they cannot rely on their in-house research and innovation capabilities.

The pilot survey reveals that approximately 40% of innovative SMEs have co-developed innovations together with their foreign partner. Taken as a whole, 60% of SMEs stated that they had collaborated in some manner for innovation with a foreign partner. Foreign suppliers and affiliates are the most important cross-border knowledge sources for the SMEs under consideration. With respect to foreign knowledge sourcing channels, strategic partnerships, public services, project-based knowledge exchanges and purchases of market surveys and technological information are also seen as important.

The Community Innovation Survey (CIS) data suggests that collaboration within the value chain (vertical) and with competitors (horizontal) increases the companies' ability to bring new products to the market, as well as the companies' economic returns to innovation (the share of turnover from products new to the market). Furthermore, we found that SMEs' innovation capabilities increase with the overall (previous) inflow of employees from MNEs. Innovation capabilities increase the companies' overall attitudes towards innovation activities (selection equation) and the companies' capability to commercialise products new to the market (outcome equation). The inflow of employees from national groups does not, however, have an effect.

Our study supports the view expressed by many that indirect support could facilitate SMEs' international activities. External investors could act as facilitators, mentors and matchmakers between potential partners and information sources. Innovative SMEs are more likely to use informal channels to access and transfer knowledge from foreign sources than to use these channels, for instance, for more direct cooperative forms.

The results imply that the current public-oriented innovation system in Finland should be made more flexible, and services differentiated for different groups of SMEs. It was highlighted that financial support for promising endeavours should be made more flexible. However, Finnish SMEs are often working too much for themselves and are reluctant to engage in open innovation because of their few resources and limited expertise in IPR issues. In this respect, there is an obvious need for external services. Supporting cross-border knowledge sourcing by different means is vital for the increasing number of SMEs in the global business environment and the world of knowledge creation.

Keywords Knowledge sourcing, innovation, internationalisation, SMEs

Preface

This publication is about internationalisation of innovation activities in Finnish SMEs. The study was carried out by VTT Technical Research Centre of Finland together with Statistics Finland and was funded by Tekes – the Finnish Funding Agency for Technology and Innovation. The study interviewed several experts from Tekes, the Ministry of Employment and the Economy, the Federation of Finnish Technology Industries, as well as several company representatives. In addition, experts from the academia (from the Turku School of Economics, Aalto University, and the Management Center Innsbruck, Austria) contributed to the study. We warmly acknowledge all these persons, not forgetting those ones that patiently responded to our pilot survey. Without them this study wouldn't have been possible. This study, for its part, significantly contributed to the academic papers presented at the IAMOT and ICSB conferences. Finally, it contributed to the general understanding of how even the smallest companies nowadays access and transfer knowledge from foreign sources.

Espoo, November 2012

Olavi Lehtoranta
Nina Rilla
Torsti Loikkanen

Contents

1. Introduction

Small and Medium-sized Enterprises (SMEs[1]) form the backbone of national and regional economies. As the bulk of value added and employment falls upon SMEs, their performance is important to national and regional economies. Moreover, through their entrepreneurial and creative activities, SMEs play a crucial role in creating and sustaining the all-important underlying dynamics and regeneration within an economy that leads to change and growth. Thus, their ability to meet the new challenges and opportunities of the knowledge economy will determine the competitiveness of national and regional innovation systems. Indeed, entrepreneurship is recognised as a major driver of innovation, competitiveness and growth. Entrepreneurship and small businesses are key sources of jobs, business dynamism and innovation. If industrial production is gradually transferred to other countries, the generation of new growth enterprises and the promotion of entrepreneurship become increasingly important.

Although some of the issues that are related to entrepreneurship and SME growth centre on the entrepreneurial culture itself and the initial process of new firm formation (see, for example, Freytag and Thurik 2007), there are also key issues around the survival and expansion of new firms once they have been established[2]. Small firms face a number of key challenges and barriers in terms of their growth and development, particularly with respect to how they access, absorb and seek to develop overseas knowledge, innovation, markets and resources. The reasons for these issues and why we should explore this issue in greater detail centre on a number of key observations, which are outlined below.

First, competitiveness is innovation driven, and innovation, in turn, is increasingly knowledge driven. The growth and competitiveness of companies largely depend on their ability to take advantage of the international arena for innovation. Even large multinationals recognise that they cannot rely on their in-house re-

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[1] We define SMEs as companies with fewer than 250 employees. Thus, we deviate from the definition used in public funding, which, in addition to the aforementioned condition, only counts SMEs with an annual turnover of up to EUR 50 million and/or an annual balance sheet total of no more than EUR 43 million. Further, micro-companies have 1 to 9 employees, small companies 10 to 49 employees and medium companies 50 to 249 employees, EU Commission (2006b), (http://ec.europa.eu/enterprise/policies/sme/files/sme_definition/sme_user_guide_en.pdf).

[2] As a result, new and small firms face major barriers or 'thresholds' to growth (Taylor 1975).

search and innovation capabilities. Thus, the ability to absorb, reconfigure and exploit relevant knowledge is increasingly recognised as key to a company's overall business strategies, especially to its knowledge and innovation activities. Where the knowledge is generated becomes less relevant compared with how it can be obtained and incorporated into its overall activities.

Second, and on a related note, the process of generating knowledge and tapping into all types of sources for innovation has become both *more complex* (relying increasingly on complementarities of skills and knowledge) and *more international*. As part of this process, we observe an increasing complexity and heterogeneity of innovation activities, a continuing need for cross-fertilising technologies, a growing trend of associated costs, and an accelerated technological obsolescence. These trends lead to the increasing importance of combining firm-related and external knowledge and the need to obtain information from global lead markets. As a result, fewer firms can find all of the inputs and assets they need in their immediate environments. Consequently, the ways in which companies are able to link into the international circuits of knowledge generation and other sources of innovation are becoming ever more crucial.

Third, the focus of attention and analysis to date has been almost exclusively on how multinational enterprises (MNEs) and, to a lesser extent, public research institutions (PRIs) have expanded their research and development (R&D) and innovation activities and developed internationalisation strategies to support this expansion. However, although both of these developments have direct implications for SMEs and their knowledge and research, technology, development and innovation (RTDI) strategies and activities, we know little or nothing about the scale and scope of SMEs' international activities or, more specifically, the *international dimension in their knowledge and RTDI strategies and activities*.[3]

Last, and linked to the above, policy frameworks and supporting policy schemes are especially important for SMEs, which often lack the resources needed to take advantage of the international activities necessary for their development. They are also more influenced by 'policy locales' in the sense that they have less opportunity to 'shop around' in different locations to pick up alternative funding streams or better policy offerings, as they are (usually) single site firms. On a related note, they also have less opportunity to avoid poor or weak policy environments. As a result, more knowledge of SMEs and the internationalisation of their knowledge and innovation (K&I) activities is needed to design appropriate frameworks and support mechanisms.[4]

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[3] For example, in the area of international R&D, the majority of the literature and research concentrate on the activities of large multinational enterprises (MNEs). The international R&D activities of growing technology- and knowledge-intensive SMEs have received surprisingly little attention (Ahvenharju et al. 2006).

[4] For the purposes of this study, we add the term "knowledge" to research, technology, development and innovation (RTDI) activities to stress the importance of different types of knowledge generation and application in addition to traditional RTDI activities, such as the sourcing of knowledge in the form of monitoring or acquiring talent or market knowledge for the innovation process. For reasons of convenience, we abbreviate knowledge and RTDI activities as K&I activities.

A major premise of this study is that companies have to rely increasingly on knowledge created outside of them (external knowledge). Further, much of this knowledge is increasingly generated internationally (Howells and Roberts 2000). Additionally, combined with the growing dispersion of the knowledge needed amongst various actors and countries, the growing knowledge intensity of products and services is leading to the need for increased international strategic technology partnering (e.g., Duysters and Hagedoorn 2001; Narula and Hagedoorn 1997). More generally, for many companies, sourcing external knowledge requires increased internationalisation (Howells et al. 2004).

The ability to monitor, obtain, co-generate and integrate external knowledge has become a major success factor for companies. For example, a study undertaken in Germany indicates that external knowledge – both market and technological knowledge – is intensively used for the innovation process of companies. Moreover, there are differences in the significance of external knowledge among sectors (Edler 2003), which strengthens the need for a sectorial analysis. The conclusions from the results of that study (Edler 2003) for this study are that *external markets* and *technological knowledge* are of increasing importance to the innovation activities and the success of companies.

As in most areas, knowledge creation is becoming increasing ever more rapid, and this knowledge is becoming distributed widely across the OECD countries and increasingly outside of them (e.g., to China and India). Obtaining such knowledge has become highly important, regardless of wherever it is generated. Similarly, as *markets* become more international, the need to know about (changing) *customer preferences* and *market regulations and standards* in foreign markets becomes more important to the innovation processes of firms, and all instruments used to secure this knowledge for the innovation process become more important as well. These dynamics differ among sectors depending on the overall research intensity of the sector in question.

These dynamics further differ among the types of SMEs across sectors. For example, research-intensive companies (high share of R&D expenses in turnover) are more in need of leading-edge technological knowledge, regardless of where it is produced, and producers of specialised instrumentation need prospective knowledge about specific market regulations and customer preferences. These characteristics are not only determined by the sector but also by the nature of the SMEs themselves (e.g., R&D intensity and heterogeneity of international markets), as well as their positions and roles in the value chain.

Large MNEs are well equipped to set up their own international knowledge sourcing systems. They may do so, for example, by acquiring specialised companies or setting up internationally distributed labs and global monitoring systems. In contrast, many (though certainly not all) SMEs face greater challenges in monitoring and obtaining globally distributed market and technological knowledge.

Studies on knowledge sourcing have thus far left an important gap, as they do not systematically explore the meaning of international knowledge sources (market and technological knowledge) in relation to national or regional sources. As a

consequence, this gap reveals the need to further explore the instruments used, the relevant framework and the policy conditions and constraints.

1.1 Some relevant specificities of SMEs

To properly grasp the extent, processes and motivational patterns that drive the internationalisation of K&I within SMEs, we must first generate an in-depth understanding of the SME "sector." There is no "typical" SME, just as there is no "typical" MNE; they are not a monolithic organisational form, instead displaying great differences (Dunning and Narula 2004).

However, a range of characteristics from different types of SMEs influence the likelihood that an SME will engage in international K&I activities. These characteristics shape the relation between general international strategies and K&I activities. When analysing SMEs' strategies and activities, we must take a differentiated view to properly understand the structure, strategy and behaviour of SMEs in different environments and with different business models. These differences include differences in the sector, the role in the value chain and chosen strategy, the business model and/or the research intensity. These differences account for intersectorial and even intrasectorial variations or similarities. This section summarises only some of these major features, which will be important dimensions in the empirical analysis.

First, compared with MNEs, there is a range of structural differences, such as the greater resource constraints of SMEs, that necessitate efficient allocation mechanisms of scarce resources and might constrain strategic opportunities. At the same time, SMEs often also display organisational modes with flatter hierarchies and are more manager- and/or founder-centric. This structure allows them to react more flexibly and dynamically to technological and market changes.

Second, the role of SMEs in their sectorial value chain varies considerably. SMEs have often sought competitive advantages that either consist of special product/market niches or specialised roles in the value chain, such as supplying and/or offering services to large firms. This positioning also influences the relationship between a SME and its large company counterparts. This relationship can be of either a competitive nature or a mutual dependency, which is best described by the term "dynamic complementarities". These positions and relationships may also vary with the maturity of the sector or the underlying primary technologies (Rothwell and Dodgson 1994).

Third, there is an enormous heterogeneity with regard to the role and intensity of K&I activity and intensity not only among different sectors but also within the same industrial sector. Different sectors, strategies, objectives and business models call for varying extents and intensities of K&I activities. Figure 1 illustrates a simplified but helpful characterisation of the different types of SMEs in terms of their K&I competences and capabilities.

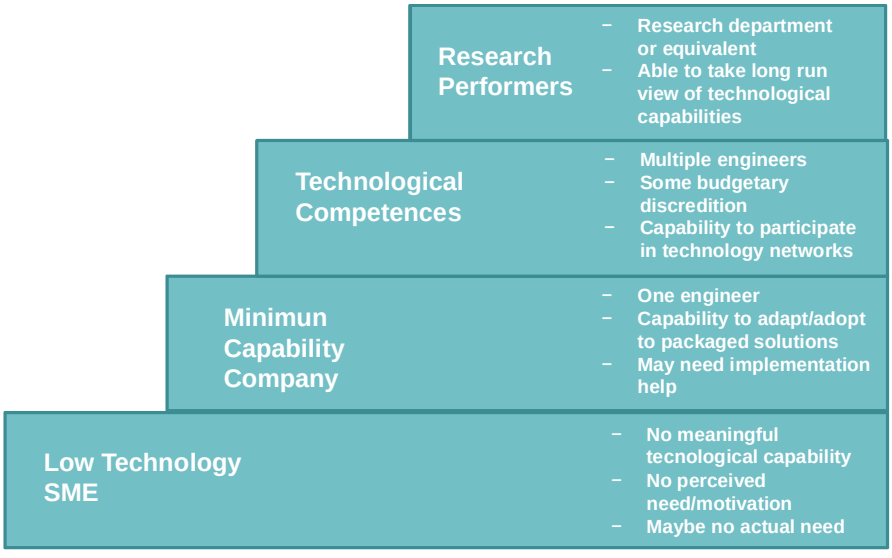

Figure 1. Different research, technology, development and innovation capabilities of SMEs (Arnold and Thuriaux 1997).

For many of these reasons, SMEs may face constraints on innovation not experienced by MNEs. Their innovative activities diverge in character from those of large companies: SMEs are often engaged in sporadic innovative activities that lack a continuous base (e.g., Narula 2004). At the same time, SMEs engage significantly less in innovation cooperation than MNEs. Thus, even though cooperating firms have a higher probability of innovating, a large number of SMEs, especially those with fewer than 100 employees, still do not cooperate in terms of innovation (EU Commission 2004), especially in the international arena. For both reasons, this finding implies that a larger proportion of SMEs need more external stimulus and support to engage in cooperation. In relation to the heterogeneous nature and role of SMEs hinted at above, SMEs show different trajectories in terms of international activities.

We claim that understanding the internationalisation of SMEs' K&I activities is a complex task requiring a holistic and interdisciplinary approach. Knowledge of SMEs' possibilities to participate (either directly or indirectly) in global K&I production and distribution is still vague. Our study aims to contribute to this gap and seeks to ultimately increase our theoretical understanding of the processes by which knowledge is internalised, as well as their policy dimensions.

1.2 Main results of the study

The pilot survey of this study focused on innovative SMEs in certain sectors ranging from medium/low to high intensity of technology or knowledge. We found that approximately 40% of innovative SMEs have co-developed innovations together

with their foreign partner. Taken as a whole, 60% of SMEs stated that they had collaborated for innovation with a foreign partner. The shares of cross-border collaborators are nearly the same (approximately 57%) in both mechanical engineering and in technical services.

The most important types of knowledge acquired from abroad by SMEs are in the following order:

1. technological and scientific knowledge,
2. wishes, ideas and design,
3. knowledge of markets and business environments,
4. knowledge of business models and ways of action.

In technical services, the most important type of overseas knowledge acquired by international SMEs is knowledge of competitors' business models and ways of action. In mechanical engineering, the knowledge of markets is clearly the most important type, followed by the knowledge of customers' wishes and ideas and of customers' business models and ways of action.

Approximately 40% of innovative SMEs give a high or medium high importance to foreign customers and suppliers as their foreign knowledge sources, and 25% reply that it is important to monitor foreign competitors. Competitors or other companies in the sector are monitored, especially when the SMEs are searching for knowledge on their business models and ways of action. Competitors outside of Finland seem to be more important knowledge sources, especially for high-growth service companies. In mechanical engineering, foreign competitors were not given as high importance. There is also a difference between internationally and domestically operating service firms: domestically operating SMEs consider competitors to be more important than international SMEs do. They also give a higher importance to public and private non-profit research institutes than international SMEs do.

Foreign suppliers and affiliates are the most important cross-border knowledge sources for the SMEs under consideration. With respect to foreign knowledge sourcing channels, strategic partnerships, public services, project-based knowledge exchanges and purchases of market surveys and technological information are also seen as important. SMEs that highlight the purchasing of knowledge, patents and licenses value strategic partnerships less. Accordingly, there are two basic strategies on knowledge sourcing: the co-development (collaborative innovation) and the purchasing-based strategy.

In technical services, a strategic, long-term partnership with a foreign partner is perceived as the most important way to obtain access to cross-border knowledge among SMEs operating internationally. Among the SMEs not operating internationally, supplier relations are valued higher for sourcing innovation information than in-house R&D activities. In contrast, in mechanical engineering, sourcing market reports and technological knowledge from abroad comes as the first mean of accessing knowledge, followed by foreign affiliates' R&D, strategic partnerships and supplier relations. Non-international SMEs regard only foreign affiliates and suppliers as important knowledge sources but have not established any longer-term relations with foreign partners to source knowledge.

The correlation tables of the survey variables show that the higher the absorptive capacity of an innovative SME is, the more often it will collaborate for innovation with its foreign customers, end users, research institutes and universities. For SMEs that rank the non-availability of domestic knowledge high as a motive for using foreign knowledge in innovation, technology transfer is important. However, the correlation with the reduction of R&D expenses is much lower. SMEs that want to reduce their R&D expenses typically also want to focus on their core business.

When we inquired about the companies' internationalisation objectives for the years 2010–2015, 70% of SMEs mentioned that starting cooperation with a company outside of Finland is of high or medium importance to them. Starting cooperation with a foreign company and establishing a strategic alliance with it was highlighted by biotech companies and technical service companies in particular. Introducing new K&I sourcing and transfer mechanisms was seen as especially important in the technical services sector.

When using the whole sample of 909 innovative companies over all sectors included in the Community Innovation Survey (CIS), we found that collaboration within the value chain (vertical) and with competitors (horizontal) increases the companies' ability to bring new products to the market, as well as the companies' economic returns to innovation (the share of turnover from products new to the market). Comparable results were also found for the reduced sample of 693 SMEs.

Furthermore, we found that SMEs' innovation capabilities increase with the overall (previous) inflow of employees from MNEs. Innovation capabilities increase the companies' overall attitudes towards innovation activities (selection equation) and the companies' capability to commercialise products new to the market (outcome equation). The inflow of employees from national groups does not have an effect.

Our study supports the view expressed by many that indirect support could facilitate SMEs' international activities. External investors could act as facilitators, mentors and matchmakers between potential partners and information sources. Innovative SMEs are more likely to use informal channels to access and transfer knowledge from foreign sources than to use more direct cooperative forms.

As highlighted in the workshop organised by our research team, we have quite a public-oriented innovation system in Finland. The system should be made more flexible, and services should be differentiated for different groups of SMEs. Financial support for promising endeavours should be made more flexible. Traditional instruments are not enough anymore.

However, Finnish SMEs are working too much for themselves and are reluctant to engage in open innovation because of their few resources and limited expertise in IPR issues. In this respect, there is an obvious need for external services. Supporting cross-border knowledge sourcing by different means is vital for the increasing number of SMEs in the global business environment and the world of knowledge creation.

2. Research set-up

2.1 Objectives and definitions

Given the stated lack of understanding or evidence regarding the activities of new and small firms in terms of how they interact with, manage and use knowledge and innovation on an international basis, the main objective of this study is to understand the internationalisation of knowledge and innovation activities in Finnish SMEs and the impact of internationalisation on SMEs and their innovation performance.

This study has the following objectives:

(1) To describe the status of international knowledge and innovation (K&I) activities in Finnish innovative SMEs and the Finnish innovation system.

(2) To analyse different types of international K&I activities and their relative importance to innovation and to SMEs to understand the combination of driving factors, motives, and barriers for international activities (or non-international activities) and their development, including their relation to MNEs.

(3) To examine the strategies and management techniques used by SMEs to take advantage of international knowledge and technology and to access, seek to develop and absorb overseas knowledge and innovation.

(4) To outline the relevance and effects of external conditions and policy support mechanisms, to identify bottlenecks as well as good practices in these conditions[5], and to assess how these processes and effects influence specific industrial sectors.

Companies are addressing the globalisation of K&I by engaging in international K&I cooperation with other companies or with research institutes, relocating their

[5] Framework conditions include human resources and employment conditions, the science base, the regulatory framework and the fiscal environment. As the main focus in this study, external conditions include networking and collaborations among firms, their entrepreneurial activities (e.g., spin-offs and spin-outs), IP management, absorptive capacities, public-private collaborations and access to high-quality, mobile labour forces and finances (de Jong et al. 2008).

research and innovation activities to facilities abroad or even outsourcing their research and development to companies abroad. These strategies are the main approaches of manufacturing companies and are increasingly also used by service companies to access, assemble and generate relevant knowledge to succeed in their innovation activities. At the same time, the analysis of K&I globalisation suffers from large multinational firm bias, as many studies tend to concentrate on analysing the K&I strategies in MNEs.

In this study, innovation is understood to be an invention commercialised in the market by a firm or an equivalent organisation (OECD 2005a). Innovation can assume the form of a product, service or process. Following this logic, an innovative company is a company that has developed and commercialised at least one innovation in the market.

In addition to these general definitions, we apply some additional definitions in analyses based on the Community Innovation Surveys and/or sector surveys conducted as part of this research. These definitions are presented in the box below.

Definition for innovation activity:

a. During the years 2006–2008, did your enterprise (see the enterprise ID) introduce new projects or activities, the target of which was to develop and/or commercialise new product, service or process solutions (i.e., innovations)?

b. Did your enterprise (see the enterprise ID) engage in the abovementioned innovation activities during its lifetime?

Definition for international operations (in market presence (incl. exporting), production, R&D activities):

Did your enterprise engage in international business operations during the years 2006–2008?

Definition for foreign knowledge sourcing:

Foreign knowledge sourcing means knowledge sourcing outside of Finland.

2.2 Sectors under study

Our study comprises five sectors: biotechnology, medical devices and engineering, mechanical engineering, consumer electronics and technical services. The selection of these sectors is governed by the criteria relevant to the research questions to be answered (i.e., to gain understanding of the meaning of international activities in terms of knowledge generation and its application to innovation in companies). The selected sectors present industries that typically vary in their degree of technological intensity, internationalisation and other categories.

The following evaluation criteria guided the selection:

- importance and intensity of inter-firm and industry-science cooperation and networks,
- research intensity of a sector,
- knowledge intensity of the technological areas most important in a sector,

- speed of technological development,
- level of internationalisation (of MNEs for that matter).

Table 1 presents the main differences between the five selected sectors according to the selection criteria.

Table 1. Summary table of the sectors in the study.

Industry	SMEs' position in value chain	Markets	Technological intensity*	Degree of internationalisation*	Nature of innovations
BIOTECHNOLOGY The key enabling technologies of biotechnology are in use (e.g., in pharmaceuticals, agriculture, food, energy and environmental remediation).	Biotech firms are, on average, rather small and function either as highly specialised suppliers or as standalone SMEs. Framework conditions (regulation) are crucial for location decisions.	Extensive legislation regulates the innovation and commercialisation activities of the industry.	High	High	Science-based
MEDICAL DEVICES/ENGINEERING, NACE 33.1 The sector includes a wide range of technologies and innovation, including basic medical equipment and nuclear magnetic resonance-, laser- and nanotechnology-based devices.	The sector is rather diverse, with only a few, dominating MNEs and a high number of SMEs. The smallest and youngest are the most innovative and research intensive. They are inclined to cooperate with large companies. They are often standalone firms with high-technology products.	This sector consists of highly regulated markets with established international standards and market accessibility.	High	High	Demand-/science-based
MECHANICAL ENGINEERING, NACE 28 The sector includes, for example, manufacture of metal products, such as tanks, reservoirs and containers, and processing of metal.	The majority of SMEs operate in a b-to-b environment. Subcontractors or contract manufacturers are increasingly faced with global competition from MNEs.	These firms operate mainly in domestic markets, with a few exceptions involving international value chains.	Medium/ low	Low	Demand-based, incremental innovation

CONSUMER ELECTRONICS, NACE 32 The sector consists of the manufacture of radio, television and communication equipment, sound and video recordings, and associated goods and electronic components.	SMEs are extremely dominant in terms of numbers, but they are scattered, and their market shares are low. They are mainly suppliers to large companies. This strategic sector is at a global level because of its technological complexity and development.	Highly globalised and technologically intensive sector. Offshoring of production is a common procedure.	High/ medium	Medium	Complex demand-based
TECHNICAL SERVICES, NACE 74.2-3 The technical services consist of architectural and engineering services and related technical consultancy and technical testing and analysis.	These firms play a key supporting role in sustaining and enhancing the performance of other manufacturing and service industries. They provide standalone services to other SMEs and MNEs.	This industry contains a quite localised (domestic) client profile. Some larger SMEs exhibit higher levels of international engagement.	Knowledge-intensive services	Medium	Demand-based, close client relationship

* Self-assessment by the authors.

2.3 Research design

The main objective of this study is to use multiple approaches to gain an understanding of the international knowledge and innovation activities among Finnish SMEs in general and in the selected sectors and case companies in particular. It can be shown that high-, medium- and low-tech companies can be found across all sectors, including knowledge-intensive sectors (e.g., the medical engineering and pharmaceutical industries) and sectors with lower levels of knowledge and research activities (e.g., the food and textile industries). The same results could occur for knowledge-intensive firms, which are measured by a high share of qualified labour. Knowledge-intensive companies are found across all sectors and not merely in knowledge-intensive sectors.[6]

[6] Companies can be differentiated into high-tech companies (companies whose R&D expenditures are more than 7% of the turnover), medium-tech companies (companies whose R&D expenditures are between 2.5% and 7% of the turnover) and low-tech companies (companies whose R&D expenditures are below 2.5%) (Legler and Frietsch 2007).

Consequently, the study consists of three main blocks of research: statistical micro data analysis, sector surveys and a qualitative case study.

Micro data analysis

In the micro data analysis, where all sectors and firms included in the Community Innovation Surveys (CIS) are considered, we analyse different outside-in innovation activities, such as new products and processes developed by others, external R&D and collaborative innovation (domestic, international) and their impact on the innovativeness of Finnish firms and SMEs, including their relations to MNEs.

We analyse whether international collaborations impact the innovativeness of Finnish firms and whether India and China have focal roles as host countries of the collaboration partners in the innovation processes of firms. India and China are distinguished in CIS2006. All other EU countries and prior surveys collapse India and China into a broad category of Asia. In Finland, CIS data can be linked with data from the Business Register, R&D Surveys and employer-employee data to augment the somewhat narrow view of the statistical innovation surveys.

We then investigate whether the inflow of employees who formerly worked for an MNE impacts the innovation capabilities of SMEs in the Finnish innovation system. For this analysis, we link CIS2006 and the employer-employee data and the Business Register data.

Survey

The second approach focuses on sector surveys in the five sectors. The objective of the survey is to gather data systematically on innovation-active SMEs across the selected sectors by means of a set of surveys to enable cross-sectorial analysis. Ultimately, we analyse the data across all dimensions that make – or might make – a difference in the forms of international activities, motives, hindrances, and benefits.

The sampling and selection of companies in the sectors is conducted based on the available data. In this study, innovation-active SMEs are drawn from 7 large datasets on firms' R&D, innovation and patenting activities; specifically, they are drawn from all of the R&D and Innovation Surveys conducted by Statistics Finland from 1991 to 2006 (2008), the Database of Finnish Innovations (Sfinno) maintained by VTT Technical Research Centre of Finland, the data on firms' Tekes[7] customership and the data on firms' patenting activities in the US Patent and Trademark Office (USPTO), the European Patent Office (EPO) and the National Board of Patents and Registration of Finland (NBPR) from 1985 to 2006 (see Appendix 1 for the description of the datasets). Here, we follow a pragmatic approach by taking a full sample of all innovative SMEs when feasible and a representative sub-sample when necessary.

[7] Tekes – the Finnish Funding Agency for Technology and Innovation.

Next, a first investigation into the structures (e.g., foreign ownership and membership in a group), addresses and webpages of the selected innovative companies is conducted. Foreign owned firms and some non-active (in 2009) firms are excluded from the data. Firms established before 1990 according to the Business Register are also excluded. After this phase, we search for contact information within these firms. The email or web domain addresses were found for slightly more than 700 SMEs. The firms not reached and the firms that refused to answer were dropped from the list. Thus, we ended up with 630 SMEs in our target sectors. An electronic Digium web survey was conducted from February to March 2010. The survey included specific questions on the innovation knowledge sourcing practices (mechanisms) in SMEs. The response rate was 22 per cent (see Appendix 2 for the questionnaire).

Case study

The third research approach consists of case studies. To obtain a deeper understanding of the phenomenon in question, we complemented the quantitative data with qualitative data, as lessons for management and policymakers are context specific. We conducted three case studies and some additional company interviews to support the quantitative analysis. The additional company interviews are not included in the case analysis. The selection criteria ensured that the cases covered the most important dimensions, such as the knowledge or research intensity, innovation or growth performance, meaning of external conditions or other variables that proved to be meaningful in the sectorial analysis.

The suitable cases were selected from the survey population, where the respondents were preferred. However, because of the small number of respondents in certain sectors, we had to extend our sample to the whole survey population. We used each firm's engagement in cross-border knowledge sourcing as the first selection criterion. The second criterion was that the company had developed and commercialised an identifiable innovation; by "identifiable", we mean an innovation that is included in the Sfinno database (see the description in Appendix 1). Third, we looked at the growth performance of the company. The key informants were the CEOs of the interviewed SMEs, and the interviews were conducted in spring 2011. Companies were approached with a semi-structured interview guide that included questions on the innovation activities of the firm, its internationalisation, its cross-border K&I sourcing practices and its absorption of knowledge (see Appendix 3 for the complete interview guide). The background information of the case companies and the data collection is provided in Table 2.

Table 2. Background information of the cases.

Firm		Description*	R&D	Data collection
BonAlive Biomaterials Oy	Case A	Est. 2009 Emp.: 10–19 Turnover: 0.2–0.4 Sector: Biotechnology BonAlive technology was brought to firm via management buyout in 2009. The current CEO had worked in the international marketing of BonAlive technology in the firm holding the technology previously. Ownership (2011): Sitra, firm management.	R&D team: 1 full-time person. Basic research in close collaboration with universities, application development in-house.	Interview with CEO April 2011, Espoo
Panphonics Oy	Case B	Est. 1997 Emp.: 1–4 Turnover: 0.4–1 Sector: Electronics Firm has been managed by an external CEO, the current CEO since late 2002. Ownership (2011): Sitra, SieviCapital Oyj, company management.	Firm conducts no basic research (ended in 2007), only product development. No formal management for R&D collaboration, more of an ad-hoc activity.	Interview with CEO April 2011, Espoo
KennoTech Oy	Case C	Est. 2003 Emp.: 5–9 Turnover: 0.4–1 Sector: Mechanical engineering Contract manufacturer and design service provider. Ownership (2011): 4 partners, 3 business angels, firm's current or ex-employees.	The R&D team consists of CEO and sales manager and production manager.	Interview with CEO and business development manager April 2011, Espoo
Planmed Oy	Not analysed as a case.			Workshop presentation March 2011, Espoo
Mobidiag Oy	Not analysed as a case.			Interview with CEO, April 2011, Helsinki

* Firm size figures in 2010 obtained from Inoa.

Workshops and policy interviews

Based on the above approaches, the relevance and effects of external conditions and policy support mechanisms on the international knowledge and innovation activities of SMEs were outlined. In addition to the case studies, some information was gathered from background interviews with decision makers and from a workshop organised with firm representatives, industry actors and policymakers. These discussions provided insightful background information on the studied phenomenon, helped to limit the study and aided in drawing policy conclusions (see the list of interviewees and workshop participants in Appendix 4).

3. Selected sectors

3.1 Life sciences – biotechnology and medical devices

Modern biotechnology is an exceptionally international high-technology sector. Biotechnology is truly a cross-sectional area that has impacted several traditional and emerging sectors, and the key enabling technologies of the 21st century have made significant contributions to major advances in the basic sciences. Biotechnology is used in pharmaceuticals, healthcare (especially in diagnostics), agriculture, food, chemical processing, energy, environmental remediation and other sectors. Within these areas, the pharmaceutical and health sectors clearly dominate, as biotechnology applications have been used to improve treatment and provide more delicate diagnosis tests. Additionally, biomaterials have been used in surgery. Over half of the Finnish biotechnology firms operate in the medical sector.

Statistical data based on the common OECD definition report that approximately 2,000 biotechnology companies are employing 96,500 employees within 18 European countries. However, given biotechnology's enabling effect, employment in industries using biotechnology products is many times higher.8 Within the EU, most companies are located in Germany, the UK and France, followed by the Netherlands and the Scandinavian countries (Critical I 2006, Papatryfon et al. 2007).

Biotechnology firms are typically so-called 'born global' firms that seek international markets from their founding or shortly thereafter. The often radical nature of the innovations developed in the biotechnology sector requires wide international markets and forces firms to pursue strong market-oriented strategies in internationalisation (see, e.g., Brännback et al. 2007). Most biotechnology firms are small or micro sized players (i.e., so-called dedicated biotechnology firms (DBFs) that hold specialised positions in the overall sector value chain). They often act as suppliers or service providers to large MNEs. One can distinguish mere discovery- or technology-oriented firms from biotech service and suppliers or biotech production companies. In contrast, the standalone SMEs, also called FIBCOs (fully integrated biotech com-

[8] The Joint Research Council's Bio4EU Study – April 2007, The Biotechnology for Europe Study: Consequences, opportunities and challenges of modern biotechnology for Europe.

panies), manage the whole value chain on their own. These companies represent direct competitors to the large incumbent MNEs (Peters and Young 2006). Table 3 provides an outlook on the relationships between value chain activities, internationalisation and business models in the biotechnology sector.

Table 3. Value chain in the life sciences sector. Modified from Peters and Young (2006).

LIFE SCIENCES VALUE CHAIN	INTERNATIONALISATION	BUSINESS RELATIONSHIP MODALITIES
HQ functions, Decision making, HRD, Technology, Procurement	Domestic with access to innovative milieu, but potentially mobile (to US).	Wholly owned.
Discovery	Domestic.	Wholly owned.
Small-scale production		
Pre-clinical testing	Domestic and/ or international.	Wholly owned. Licensing-in or -out.
Phase I		
Phase II		
Phase III		
Full-scale production	Global – least cost locations.	Strategic alliances (contract manufacturing arrangements).
Marketing & distribution	Domestic base, but potentially mobile (closer to main markets).	Small firms commonly collaborate with large drug/biotech firms.
Markets	Global, but US market critical.	Small firms commonly collaborate with large drug/biotech firms.
Company growth	Global.	M&As are common, along with strategic alliances.

In Finland, approximately 150–200 companies are active in the field of biotechnology, excluding supporting companies (i.e., service companies, subcontractors or consulting firms [Finnish Bioindustries[9]]). Approximately 120 of them (i.e., close to one-tenth of all European biotech firms) were R&D active firms captured by R&D Surveys in 2007[10]. Typically, biotech firms in Finland are relatively young and R&D intensive. Many of them are still in the product development phase. Therefore, the availability and functioning of persistent public funding and venture capital are critical factors in this R&D-intensive sector. Most of the firms were founded in the

[9] http://www.finbio.net/fi/

[10] Based on the author's own calculations.

late 1990s, and the majority of the new companies in the field have emerged from research and innovation that originated in universities or institutes of technology. Intense university-private sector cooperation in the sector is required because of the strong focus on basic research. Regionally, biotechnology firms are concentrated around the local Science Parks and universities. The biotechnology sector is fairly well networked through the BioCenter Finland and HealthBio cluster, which gather the main university units and other actors together.

As mentioned previously, the majority of the biotech firms in Finland are small and employ fewer than 20 employees (Critical I, 2006). Slightly over half of the companies operate in the health sector and conduct R&D. There are 30 companies developing drugs. In total, 40 companies are engaged in vitro diagnostics, and Finland has ten biomaterials companies. All of these companies intend to place products on the international market. Finland also has a significant presence in industrial-scale enzyme production. Some companies concentrate on high-quality enzymes for research. A little less than half of the Finnish biotech firms target industries other than healthcare (e.g., chemicals, foodstuffs [health-promoting food] and forestry). Especially with regard to foodstuffs, applications in environmental protection and bioinformatics have a high market potential in the future[11]. In addition, Finland is also in a fairly good position to utilise biotechnology in industrial processes. Companies are well networked, which benefits the applications of a new technology.

Constituting a highly knowledge-intensive sector, these firms must be close to the global knowledge frontier already in the R&D phase, which turns the firms' ability and capability to adopt the latest scientific results into a key factor for success (McMillan et al. 2000). They need to source knowledge from the leading universities and to access potential collaboration partners, licensees and/or further sources of investment on a worldwide scale constituting major drivers of internationalisation. Global presence is also important for preventing later obstacles and time delays because of different regulatory regimes. In addition, the continuing consolidation processes (i.e., mergers and acquisitions [M&As]) on an international scale has increased, strengthening the international linkages of even the smallest biotech firms[12]. However, according to OECD (2008), better data on the barriers of growth for biotech firms are required. The extent of current SMEs' international engagement for the sake of K&I sourcing and distribution as well as its impact on firm success or failure have not been sufficiently explored from firm or policy perspectives.

11 Health-Bio Terveyden bioteknologian klusteriohjelma [Health-Bio Health Biotechnology cluster programme]. Strateginen ohjelma-asiakirja[Strategic programme-document] 2007–2013.

12 Health-Bio Terveyden bioteknologian klusteriohjelma [Health-Bio Health Biotechnology cluster programme]. Strateginen ohjelma-asiakirja[Strategic programme-document] 2007–2013.

Medical devices/engineering

In addition to biotechnology, the life sciences sector in Finland also includes the medical devices sector, which has been one of the positively developing high-technology sectors since the mid-2000s in Finland. Innovation in medical devices has been a powerful force in improving healthcare through new and enhanced therapies and diagnostics. For example, the resource-scarce healthcare sector worldwide is currently seeking solutions from diagnostics devices – a subsector that is especially strong in Finland.[13]

The size of the European market is approximately 30–34% of the global sales market. Up to 8% of medical technology sales were reinvested in R&D in 2009, and the annual growth rate for the European medical technology industry is approximately 5–6%. The US market is the largest single market in the world, which makes several US companies active global players. Japan has the second largest share of global markets, with a share of 14–15%. Aging populations and the incessant supply of new technological opportunities are likely to remain key drivers of growth in many countries.

However, similar to the biotechnology sector, firms producing medical devices have also sought international markets since their inception because the Finnish market is relatively small (though well developed), and medical technologies are used at a high level because of the country's well-developed healthcare system in which well-being, public health and healthcare are high priorities. The share of Finnish medical technology production is approximately 0.5 per cent of the global production and 2% of the European market. The health technology[14] exports were EUR 1 376 million in 2010 (Fihta 2011).

The medical devices sector in Finland is composed of five main categories[15]: (1) electrical diagnostics and imaging machines, (2) x-ray and radiological machines, (3) hospital furniture and equipment, (4) surgical and dental care instruments, and (5) orthopaedic and medical instruments. The largest group in production and exports is x-ray and radiological machines. This group includes dental x-ray and mammography machines, in which Finnish innovations are worldwide market leaders. In general, the exports primarily constitute the sales of medical devices in niche market segments. Given that the healthcare systems trade in public markets is demanding, it is often handled by large multinationals. For example, many Finnish companies are too small to be competitive in this market.

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[13] http://www.mediuutiset.fi/medi_promojuttu/terveysteknologia+porskuttaa/a756751# (accessed on 2.2.2012).

[14] The health technologies consist of medical equipment, medical furniture, medical implants and diagnostics.

[15] In contrast to medical devices sector, the Finnish medical technology also contains in vitro diagnostics (IVD) research instruments and reagents, which are not the focus of this study. However, many of the statistics include IVD instruments and reagents, which cannot always be extracted from statistics.

Western Europe is the most important export destination for Finnish health technology: its total share is 26% of all exports. The largest single market area is the USA, with 20% of all exports in 2010. Important markets also include Russia (6%) and Japan (5%) (Fihta 2011). Additionally, Asian markets, such as India and China, are showing rapid growth and great potential for Finnish life science firms in the future.

The structure of the medical device industry is defined by a small number of large multinational firms and a large proportion of SMEs in Europe and elsewhere. This structural balance between small and large firms is reflected in the division of labour for medical device innovation. Start-ups and small firms have been disproportionately responsible for novel therapeutic and diagnostic technologies, whereas larger firms have been more likely to focus on incremental improvements to existing technologies, which exploit their capabilities in manufacturing, marketing and distribution. Many of the SMEs operating in the medical technology sector are high-technology and highly research-intensive companies (Pammolli et al. 2005). Furthermore, in many cases, the small innovating firms display a high propensity for collaborating with the larger firms to bring their new technologies to market, and large firms often develop their technological capabilities by licensing from and acquiring the smaller firms (The Lewin Group 1999).

The knowledge base and innovation process for medical device technologies is distinctive for its reliance on interactions between medical supply firms, university science and engineering departments and the clinical community. The impetus for innovation can come from any of these three domains, but the learning and evaluation that occurs in the context of clinical practice is always a key element in successful innovation. For this reason, links between medical supply firms and leading clinical practitioners, often residing in academic research hospitals, represent a major dimension of institutional interdependence within the medical innovation system (Gelijns and Thier 2002). The knowledge intensity of the firms operating in the sector is likely to vary considerably according to whether they are engaged in high-tech devices or more basic medical equipment. At an aggregate level, R&D intensity, measured as R&D spent over turnover, is significantly lower for this sector than for the pharmaceutical sector and is comparable with the manufacture of motor vehicles. [16] The field is notable for its globalised knowledge base, international standards of medical best practices and regulation, and opportunities to access international healthcare markets.

According to the Finnish Healthcare Technology Association (Fihta)[17], the main *strengths* of the Finnish medical technology sector are fluent cooperation among

[16] This point should be treated with some caution, as it was based on the NACE 33.1 code, which excludes many of the higher-tech medical devices.

[17] Presentation by Jouni Ihme and Terhi Kajaste FiHTA 11.12.2008 ”Suomen terveysteknologian teollisuus tänään – ja tulevaisuudessa”. Available: www.teknologiateollisuus.fi [accessed on 12.3.2012].

various actors in research, coordination of research, tight industrial focus, high inputs into R&D and high competences in design, mobile technology and diagnostics. In addition, small companies are internationally oriented and extensively networked. Conversely, the main identified *weaknesses* relate to entrepreneurs' lack of marketing, sales know-how and motivation to develop their businesses. Furthermore, the lack of engine companies and capital investors is hindering the international development of the sector.

Tightening healthcare regulations around the world, increasing bureaucratic cooperation and declining industrial focus due to the spreading of scarce resources are seen as future *challenges*. As in so many other industries, the major threat is the outsourcing of production as costs increase in this highly concentrated industry. The Finnish bio and life sciences sectors are facing global trends towards consolidation and concentration, which aims to enhance the efficiency and productivity in R&D, distribution and sales. This change has also affected Finnish medical technology companies, which have become a part of larger foreign enterprise groups, although production of Finnish medical technology has become more global at the same time, as shown in increased import figures. The main driver of M&A activities has been the decreasing number of novel ideas in the MNEs' own innovation processes because an increasing amount of R&D is acquired from external R&D-specific firms (www.HealthBio.fi). The introduction of new coordination mechanisms, actors and incentives in the industry, such as healthcare and well-being strategic competence centres (SHOK), are expected to bring new *opportunities* to the industry and the companies operating in it. Furthermore, personalised knowledge in medical care is a future global trend expected to bring new opportunities to specialised life science firms.

3.2 Mechanical engineering[18]

Mechanical engineering is chosen for the sector study because of its low R&D intensity compared with biotechnology and electronics firms and its strong reliance on tacit skills and informal knowledge development. Thus, this sector serves an important comparative purpose. Moreover, the sector is dominated by SMEs – a reflection of their reliance on "craft" methods used to serve rather narrow market segments.

The actors in the mechanical engineering sector are excessively oriented towards producing customised products for regional or national markets by using local or regional pre-existing competencies. However, the emergence of the internet and related modern communication technologies has dramatically reduced information-gathering costs and thus opened a window for these firms to learn on a global scale and reap the potential benefits of internationalisation. Similarly, such technologies enable linkages to international customers while maintaining dense information exchanges with customers and thus the flexibility and ability to

[18] Manufacture of fabricated metal products, except machinery and equipment.

customise, which has sustained their activities at home. Finally, even companies that traditionally have been fairly sheltered from international competition are now facing internationalisation in their home markets because of the same aforementioned factors.

Generally speaking, the concept of *mechanical engineering* can be used to label a broad range of activities. Therefore, it cannot be defined as a sector by output. Rather, it is labelled as a set of activities involving the refinement or processing of metal. As a starting point for the survey, the sector will be restricted to NACE 28 group companies, which process metal sheets, bars, and tubes into a varied array of infrastructure products for process industries, the construction industry, or maritime industries. This relationship illustrates how these companies are often sub-suppliers to other industrial actors and thus operate in a business-to-business environment. The definition applied is a negative one – "fabricated metal except machinery and equipment". The target here is to maintain the focus on low- to medium-tech refinement of metal.

In Finland, enterprises in the mechanical engineering industry, including machinery and equipment firms, employ 80,000 people, making this sector the largest employer in the technology industry. The sector has a turnover of EUR 19 billion (StatFin 2010)[19]. The companies in this sector know how to apply new technologies rapidly to customer-driven products and production processes. It is increasingly popular for companies to form cooperation networks that produce total solutions tailored to meet customers' individual needs. This customisation allows each company to focus on its core competence, and success creates more jobs in subcontractor companies as well (The Federation of Finnish Technology Industries).

The total volume of the subcontracting industry in Finland is approximately EUR 2.6 billion. It employs more than 16,000 people (The Federation of Finnish Technology Industries). The main part of the turnover comes from the firms operating in the fabricated metal and machinery and equipment industry. Most subcontractors are small- or medium-sized family businesses. They operate in many ways with their clients. For example, a subcontractor can be a systems supplier, a contract manufacturer, a part or component supplier or a capacity subcontractor. The main Finnish contractor companies are already global players, and their networks comprise both Finnish and global companies. Improving these networks in Finland and making them more international has become a key success factor for the main contractors as well.

The development of the Finnish machinery and metal product industry is led by clients operating in the international markets. As leading companies in their fields, these firms focus on their product and operation development both in Finland and in global production networks. In contrast, medium-sized, highly specialised firms have directed their production mainly towards domestic plants and business networks.

[19] http://tilastokeskus.fi/tup/statfin/index.html

The requirements for the supply chains tightened substantially with increased globalisation in the 2000s. Subcontractors and suppliers were increasingly entrusted with supplying goods in the chain, and a problem was that the systems and (especially) components suppliers had no capabilities to develop themselves into main suppliers. Subcontractors were small, and they had no longer-term goals or visions, no willingness or ability to take risks or not enough highly educated development personnel. In particular, components suppliers were seldom growth oriented. At the systems supplier level, foreign companies filled the markets and also took the component production with them.

The TRIO programme (2004–2009) launched by the Federation of Finnish Technology Industries responded to the challenges companies faced with respect to growth, internationalisation and networking by backing up development projects and by providing funding. TRIO's objective was to change the structure of the industry, which no longer met the requirements of its main contractors and failed to address global changes. The lack of systems suppliers formed a bottleneck, and companies were encouraged to grow into that role (Simons et al. 2009).

The starting point for the TRIO programme was that the changes in the electronics industry (globalisation of the predominantly Finnish electronics subcontracting industry) were also going to happen to the machinery and metal product industry in Finland. The measures of the programme were directed especially towards the systems and components suppliers, which were seen to be too few in Finland compared with the need. The measures entailed developing services for personnel training, technology transfer, business growth, investment financing and internationalisation. The goal of the TRIO programme was to provide opportunities to develop new types of business activities that would help strengthen production activities in the technology industry. For example, these activities are related to logistic services, knowledge creation and delivery, and services in network management. The programme helped businesses and business networks in the technology industry to start and implement their development projects. The targets of the project were the following:

- developing technology,
- developing knowledge in business operations and internationalisation,
- developing new roles in the networks.

In the TRIO programme, the business models in the ICT cluster were also carefully followed because of its fast global growth. In the ICT cluster, the component manufacturing was originally largely domestic, but during the phase called the "China phenomenon", manufacturing started to move to low-cost regions and closer to the growing markets in Asia. Consequently, the number of component manufacturers in Finland became fairly small. However, because the machinery and metal product industry is distinctive for its content, markets and competitiveness, the business models used in the ICT cluster cannot be directly applied to the mechanical engineering sector (Simons et al. 2009).

3.3 Consumer electronics[20]

The electronics industry is a key strategic sector at the global level because of its technological complexity and development. During the 1990s, the electronics industry underwent a clear shift from a highly localised industry to a highly globalised industry. Particularly, a significant proportion of manufacturing moved from high-cost to low-cost locations in Central and Eastern Europe and to Asia, with China being the main actor (Year Book of World Electronics Data 2007). The production in high-cost locations accounted for 75% of electronics output in 1995. This proportion fell to 67% in 2000, and in 2005, high-cost locations accounted for only 51% of the total (European Commission 2006a).

In 2010, the Finnish electronics industry together with the electro-technical industry employed 48,000 people and had an aggregate turnover of EUR 35 billion (Web Statfin 2010)[21]. The industry employed a further 139,000 workers abroad in its foreign subsidiaries. Expansion was particularly strong in Western Europe and Asia. Today, the major challenge of the industry is the massive offshoring of its manufacturing functions to low-cost countries. Having a technology platform designed in Western countries but industrialisation and manufacturing operations in low-cost locations is the norm for most Western electronics companies (Seppälä 2010).

The structure of the sector is mainly dominated by small- and medium-sized firms. Particularly, SMEs represented almost 98% of all firms in 2010 (StatFin 2010). This structure strengthens the role of knowledge collaborative networks by making them suitable in the analysis of the internationalisation of SMEs involved in manufacturing radio, television and communication equipment. Nonetheless, SMEs account for less than 10% of the total turnover and 27% of the employment of this sector (StatFin 2010). Considering the technological activity, the sector has shown an increasing trend towards R&D expenditures and EPO patent applications in recent years. The relevance of this high-tech sector can be observed when its share in the total R&D expenditure of manufacturing industries is considered: in Finland, it accounts for almost 73%. In line with the rise in the total number of patent applications, the number of EPO filings with multiple applicants has grown in all technology areas, most strongly in electronics, instruments and pharmaceuticals-biotechnology.

One company, Nokia Ltd, is highly dominant in the Finnish ICT cluster, accounting for 48% of all Finnish EPO patent applications from 2000 to 2006. For comparison, in the Netherlands, Phillips accounted for 36% of all EPO patent applications, and in Sweden, Ericsson accounted for 27% of all EPO patent applications. It is noteworthy that Phillips is less specialised in telecommunications than Nokia and Ericsson. Many firms in the Finnish ICT cluster cooperated with Nokia.

[20] As delineated in NACE 32 (TOL 2002).

[21] http://tilastokeskus.fi/tup/statfin/index.html

In 2000, Nokia employed more than 18,000 employees in its Finnish first-tier subcontractor and partner companies (Ali-Yrkkö 2001). However, in the early 2000s, the Finnish supplier network represented less than 20% of Nokia's total subcontracting (Seppälä 2010).

Generally speaking, the electronics industry in Finland is distinctive for its specialisation and innovativeness, fast application of technologies, combination of different knowledge bases in large systems and value-added services, professional products and demanding customer-based short series production (The Federation of Finnish Technology Industries, http://www.teknologiateollisuus.fi). In 2010, the number of firms and the concentration rates (share of the 4 biggest firms in the number of employees) in the manufacture of computer, electronic and optical products (26, TOL 2008) and in subcategories of those products were as presented in Table 4.

Table 4. The number of firms and the market concentration in the Finnish manufacture of computer, electronic and optical products in 2010 by TOL 2008 (source: Statistics Finland).

Industry	Number of firms	Concentration rate CR4 %
Manufacture of computer, electronic and optical products (26)	737	70
Manufacture of electronic components and boards (261)	216	54
Manufacture of computers and peripheral equipment (262)	86	57
Manufacture of communication equipment (263)	72	94
Manufacture of consumer electronics (264)	36	95
Manufacture of instruments and appliances for measuring, testing and navigation (e.g., watches) (265)	271	45
Manufacture of irradiation, electromedical and electrotherapeutic equipment (266)	29	90
Manufacture of optical instruments and photographic equipment (267)	21	80
Manufacture of magnetic and optical media (268)	6	..

The long-term relationships with knowledge sharing and learning are particularly common in fast-changing industries. By networking, companies obtain access to the resources of their counterparts. The role of an efficient supply chain is emphasised in industries with time-based competition. In these industries, short product life cycles, fast delivery times, rapid technological development and large product variety push companies to operate in networks. The role of information and knowledge is pivotal. Companies can obtain more information about technologies, requirements and the future development of the market through cooperation with other companies. The ICT cluster is a good example of a cluster with an active alliance policy. In addition to a growing number of alliances, inter-firm cooperation has deepened. Cooperation includes not only manufacturing or marketing opera-

tions but also R&D activities. In R&D, cooperation companies often exchange highly confidential information, such as information about the latest technology (Ali-Yrkkö 2001).

The motive for networking has also changed over time. In the 1990s, the core competence paradigm was also adapted in supply chains. Operations outside of the core competence area were outsourced. When cooperation was seen as a permanent operation mode, it was deepened, and it also spread from electronics to other manufacturing sectors.

Given that alliances allow access to complementary resources, one weakness in networking is the tremendous difference in size among partners. The needs of a large company often exceed the capacity of a smaller company. The ability of smaller companies to take risks is often low compared with the needs of a bigger partner. Pursuing common benefits requires optimising not only the material flows but also the information flows throughout the entire supply chain. Nevertheless, through successful cooperation, the supplier may obtain the status of a first-tier supplier with greater responsibility. During the past few years, the role of information has received increasing emphasis as outsourcing and networking have become more common, but at the same time, the supply chains have become longer, as they have come to include different organisations and companies (Ali-Yrkkö 2001).

The first few years of the 21st century witnessed a massive relocation of electronics manufacturing from Europe and the US to Asia and other low-cost regions via the emergence of global supply chains. The Finnish ICT cluster and the national economy have generally been influenced by this transformation in many ways. In the 1990s, Nokia became a leader in the global cell phone market. The growth of Nokia contributed significantly to the Finnish national economy, especially to GDP growth, exports and the R&D system (Ali-Yrkkö 2010). Today, most of the design, manufacturing and services provided by the Finnish electronics subcontracting network have been transferred to China and other low-cost locations around the world (Seppälä 2010).

A number of Finnish suppliers internationalised their operations in the wake of Nokia. In addition to plants, they even established R&D units abroad. Many suppliers started or increased their international operations, including foreign trade and production abroad, as the electronics industry moved intensively toward low-cost locations. In sum, as a truly global actor, Nokia has contributed both directly and indirectly to the internationalisation of a number of Finnish companies not only in the electronics sector but also in other sectors as well.

3.4 Technical services[22]

The technical services industry is a high-technology sector where the European Union has a considerable comparative advantage compared with its main industrial competitors, such as the US. The sector is important not only in terms of job and output growth but also for the key support role it plays in sustaining and enhancing the performance of the other manufacturing and service industries within Europe (including the other four sectors in this study). The industry is composed of two sub-sectors: architectural and engineering activities and related technical consultancies (NACE 74.20) and technical testing and analysis (NACE 74.30). The sector employed over 2.3 million employees in EU-25 in 2003 and generated some EUR 105 billion in value added for the same year. Those countries with average or above average shares for technical service activities (in relation to value added in 2003) within Europe included the Czech Republic, Finland, Germany, Italy, Slovakia, Slovenia, Sweden and the UK. The top five countries in 2003 in terms of value added were the UK, Germany, France, Italy and Spain, whereas the top five countries in terms of employment were Germany, the UK, Italy, France and Spain (EU Commission 2006a).

The high ratio of value added for the industry compared with other business services is also reflected in its gross operating rate, which is also high and reaches 19.8% in 2003 for the EU-25, the second highest rate among the business services. Similar to other business service sectors, the technical services industry grew strongly from 1998 to 2005 and averaged over 5% per annum over this period (although the sector shows lower than average growth rates for labour productivity compared with business services as a whole). Within the two sub-sectors, engineering design services was the most important product category within the architectural and engineering activities sub-sector, while testing, inspection and analysis services were the most important within the testing and analysis subsector. The size profile is difficult to gauge accurately, but evidence suggests that there is a number of large consultancy firms associated with architecture, engineering and testing services within Europe, below which there is a mass of small SMEs (micro firms) that are highly creative and dynamic. However, the R&D data are difficult to obtain at a disaggregated basis for the sector, as is the case for any other service sector.

Although the sector is increasingly important for European competitiveness and growth, problems remain regarding the definition of and information on the industry. Statistics Sweden (2006), for example, has noted continuing problems over the definition and subcategorisation (e.g., within engineering services) within the sector, despite its growing significance. Measurement problems also remain; for example, there are problems with capturing the export values in this sector, which

[22] As defined by NACE 74.20, architectural and engineering activities and related technical consultancy, and 74.30, technical testing and analysis.

may be substantially underreported, although German data suggest that these values are still high (Czarnitzki and Spielkamp 2000). However, consideration of only the average is likely to mask those firms with high levels of overseas orientation and those companies with a local or regional client base. These statistical problems are also reflected in the lack of real information or analysis surrounding the internationalisation pattern of the sector (Kautonen and Hyypiä 2006). There is also a lack of information on how, despite the crucial significance of overseas markets, small firms cope with the internationalisation process.

In general, the growth of production in the KIBS (Knowledge Intensive Business) sector has strongly increased since the 1990s and exceeded the growth of GDP (Lith et al. 2005). The main driver for this growth has been the change to outsourcing services in both the industry and public sector. At the same time, the Finnish technical service sector has been able to benefit from this development and has made the sector relatively strong compared with the international market. The development has been possible because of the traditional capital-intensive industries, such as the forest and metal industries, and the construction of basic infrastructure, which has provided opportunities for technical service firms to grow and develop their skills. Technical services can be roughly divided into two main groups: independent design and service firms and project engineering firms that are related to large industrial concerns. However, the majority of the technical service firms are small and employ only a few employees. Because of the relatively stagnant domestic demand, technical service firms are increasingly forced to seek growth from international markets. European countries are the main market area, but eastern European and Southeast Asian countries offer especially interesting possibilities for Finnish technical service businesses. Many of the internationally operating technical service firms also provide exporting prospects for Finnish manufacturing companies by acting as so-called engine companies. The availability of a skilled workforce in the technical services might create a possible future challenge in the sector, as the current project thinking might prevent the training of future professionals. Additionally, the sector should also pay attention to customer-oriented business models to increase its profitability and be competitive in the international markets (Varsinais-Suomen TE-keskus 2009).

4. Theories to explain international knowledge and innovation activities

4.1 Globalisation of R&D

Many studies have been conducted on the globalisation of R&D. These studies have accounted for various forms of international technological activities. The great majority of these studies have focused on large MNEs.

As a result, there is a growing trend in international activities along the three dimensions defined by Archibugi and Michie (1997):

(a) The volume of cross-border technology transfer via not only technology-intensive trade but also international licensing and patents has increased (OECD 2005b).

(b) The joint generation of cross-border knowledge has grown. Narula and Hagedoorn (1998) have summarised some core features in international cooperation patterns with four key observations: 1) collaboration is now often considered to be the first best option instead of the last resort, 2) firms increasingly use collaboration to undertake R&D, 3) firms are not only conducting more R&D through collaboration but also doing so with overseas partners, and 4) several non-traditional organisational modes (e.g., non-equity agreements) are becoming increasingly popular.

(c) Technology-related foreign direct investments (FDI) – arguably the major factor responsible for the increase in R&D expenditure in Europe – have increased considerably, as indicated by R&D investment data (input) and patent statistics (output) (see, e.g., Kuemmerle 1999; Patel and Pavitt 2000; Narula 2003).

As measured by patents with foreign co-inventors, international cooperation has risen for all major OECD countries. For example, from 1931 to 2003, this share has increased from 6 to 11 per cent for the US, from 7 to 16 per cent for France and from 12 to 22 per cent for the UK (Edler et al. 2007). Similarly, strategic technology alliances among companies almost quadrupled from 1980 to 1995 (Narula 2003). The rising importance of alliances has also been emphasised in studies (see, e.g., UNCTAD 2005). Interestingly, the sectorial or technological composition of the alliances has shifted from a predominantly information technology (IT)-dominated mode towards life sciences and pharmaceuticals. This shift also indicates the growing importance of public research institutions in these alliances, as

many knowledge-intensive companies are much inclined or forced to cooperate with cutting-edge public research institutions[23].

Furthermore, from 1995 to 2003, the R&D activities of foreign affiliates in OECD countries (with the exception of Spain) have grown much faster than those of indigenous companies (OECD 2006), with obvious consequences for local partners, including SMEs. The trend towards more internationalised R&D is set to continue. Most recently, the UNCTAD survey (2005) and the study on R&D offshoring (Helsinki School of Economics/LTT 2007) have shown that decision makers intend to internationalise R&D further. For example, 69 per cent of all companies responding to the UNCTAD survey indicated that they would increase their activities in locations abroad (UNCTAD 2005).

Further, in most of the current studies mentioned, there appears to be a diversification of international activities, especially activities related to knowledge and technology development. In addition to foreign direct investments (FDI), MNEs have established wider and more heterogeneous global networks for RTDI, including monitoring schemes, virtual expert networks, and focused strategic alliances (UNCTAD 2005 and Helsinki School of Economics/LTT 2007).

One of the well-established starting points for understanding the motivation of companies to internationalise R&D approaches the phenomenon from the knowledge utilisation perspective. Companies are said to pursue *home-base-augmenting* strategies if they locate their R&D activities outside of their country of origin to tap into the target markets' local knowledge and potential spillovers. Conversely, foreign R&D driven by demand-side and market factors is traditionally known in the literature as *home-base-exploiting* FDI. In this latter case, (re)location abroad is generally motivated by the desire to obtain and better exploit some firm-specific capabilities (Dunning and Narula 1995; Patel and Vega 1999; Kuemmerle 1999; Le Bas and Sierra 2002).

We could argue that the motivation for international activities has changed. Within the dichotomy of knowledge exploitation ("home-based exploitation") versus knowledge generation ("home-based augmentation") (e.g., Le Bas and Sierra 2002), knowledge augmentation is gaining relative importance vis-à-vis the market adaptation mode through access to the public research base and employment of "talent". Ease of access to talent and cooperation with local public research institutes drives companies to relocate, as confirmed in a number of studies (Ambos 2005; Edler et al. 2003; Gulbrandsen and Godoe 2007; Rama 2008; Thursby and Thursby 2006). Finally, costs seem to play an increasing role, at least in some of the internationalisation models followed by MNEs (Sachwald 2007).

Additionally, studies such as Florida (1997), Kuemmerle (1999), Pajarinen and Ylä-Anttila (1999) and Pearce and Singh (1992) confirm that, although motives related to both demand (close to local markets) and supply (access to human capital and technological expertise) are important in R&D globalisation, the latter

[23] See Edler (2004) and Edler et al. (2007).

have been rising. While technology sourcing motives are becoming a major force for setting up R&D abroad, both demand- and supply-related motives remain heavily intertwined. The innovative performance of the R&D laboratories shows that these sites are not mere 'listening posts' but are dedicated to the creation of new scientific and technological knowledge. Although acquiring a foreign laboratory could be a shortcut to obtaining access to localised knowledge, Kuemmerle (1999) found that greenfield investment is actually the dominant form of entry for the cases of both home-base-augmenting and home-base-exploiting activities.

Last, the regional scope of activities has broadened. Firms' inability to find, acquire or attract the in-house talents and technological assets they need may push firms to search for substitutes or complementary knowledge in ever more remote locations (Patel and Vega 1999; Le Bas and Sierra 2002). This need to tap into qualified personnel is seen by many (e.g., Kedia and Mukherjee 2009) as one of the main motives pushing companies to engage in R&D offshoring. Asia is becoming an increasingly important R&D location. There are signs that China in particular will develop into a prime location for knowledge production of MNEs and that further build-up of MNEs' R&D activities abroad will in the future be accompanied by the de-location of research activities, especially in Europe (Helsinki School of Economics/LTT 2007).

The international sourcing of technology and knowledge has become an important reason for MNEs to internationalise their R&D activities. Because of the opening of the markets, MNEs have become more mobile and are increasingly shifting the activities – including R&D – in their global value chains in reaction to differences in location factors, such as the costs of innovation (OECD 2007b). However, the internationalisation of R&D is due to not only the expansion of MNEs' operations abroad but also the dynamics and constraints of innovation-based competition.

In sum, the establishment of MNEs' R&D activities abroad usually follows the offshoring of the production units and IT and customer services. R&D laboratories may be created out of nothing (e.g., greenfield investments), obtained through a merger or acquisition, or transferred abroad (relocation) as part of a corporate group's restructuring of its R&D activities (Hatzichronoglou 2005).

R&D offshoring and outsourcing[24]

The literature on R&D offshoring and outsourcing suggests that these activities are attracted to locations featuring innovative environments with the following characteristics: (1) a skilled workforce and (2) sufficient infrastructures for knowledge creation, absorption, and appropriation. The potential to capture and utilise knowledge spillovers has an important impact on the decision of where to locate

[24] Outsourcing activities mean that activities are conducted by an unrelated party through various contractual agreements. R&D and innovation activities can be organised hierarchically or through networks, and they can be centralised or decentralised.

R&D (Feinberg and Gupta 2004). Technology sourcing has become a major consideration for locating R&D outside of the home country, and the geographic dispersion of MNEs is increasingly a means of knowledge creation rather than of knowledge diffusion. Offshoring is understood as the relocation of in-house activities to other (often low-cost) countries (Rilla and Squicciarini 2011).

The location decisions for R&D facilities that augment those of the home base are typically supply-oriented and based not only on the host country's technological infrastructure but also on the presence of other firms and institutions from which the investing firms can benefit, including spillovers from other R&D units, access to trained personnel, links with universities or government institutions, and the existence of an appropriate infrastructure for specific types of research. The R&D of these affiliates is more innovative and/or aimed at technology monitoring. Additionally, R&D is largely determined by the quality of the components of the regional or national innovation systems. The features of a host country that attract such innovative R&D vary depending on the industry and the activity. This new home-base-augmenting motivation complements the traditional demand-oriented reasons for R&D abroad (i.e., market proximity to lead users and adaptation of products and processes to local conditions). Nevertheless, the home-base-exploiting (Kuemmerle 1999) or "asset-exploiting" (Dunning and Narula 1995) motivations still remain important. In this case, because technological knowledge tends to flow from the parent firm's laboratory to the foreign-based facility, the technological advantages of the affiliate primarily reflect those of the home country, and foreign R&D units exploit the parent company's technology.

A recent review of R&D offshoring (Rilla and Squicciarini 2011) indicates that offshore outsourcing, especially of R&D, is predominantly driven by companies' willingness to find and appropriate the knowledge that they – sometimes desperately – need. Currently, the pool of skilled workforce that companies might tap into has become global, and a greater number of companies can access this repository of talents (Lewin and Peeters 2006).

One of the first industries to engage in R&D offshore outsourcing was the pharmaceuticals industry, which is an R&D-intensive sector (see Mehta and Peters 2007; Howells et al. 2008). For instance, outsourcing part of the R&D they need might be an optimal strategy for those pharmaceutical companies that do not have the human resources to conduct basic research internally. However, this outsourcing comes at a price. Outsourcing progressively bigger parts of their value chain makes firms more global (see e.g., Bottini et al. 2007) and thus makes it more difficult for them to manage the more complex configurations that emerge, as it becomes harder to coordinate the various parts of the value chain (Maskell et al. 2007).

4.2 International innovation

International K&I activities have been increasingly debated and analysed since the early 1990s within the large MNE sector (see, e.g., Rama 2008; Belitz et al. 2006).

Although a great deal of empirical work has sought to grasp the scope, motives and patterns, a common theoretical framework is still lacking. Furthermore, the impact on and the participation of SMEs has rarely attracted the focus of researchers.

In the earlier literature on the internationalisation of business, the starting point centred on the existing competitive advantages of firms that could be exploited abroad (Patel 1997). Amongst these studies, Vernon's model of the international product life cycle had a great impact. It was based on an earlier work by Posner (1961), who introduced the idea that temporary monopoly profits can be appropriated based on a technological lead. The model argued that new technologies and products will be first developed, produced and marketed in highly industrialised countries with high technology expertise and innovative demand. With a certain lag, increasingly standardised products meet a growing demand in other countries served by exports. With scale advantages and labour costs becoming central decision variables for firms, production sites would be established in the lagging countries and gradually become substitutes for the ones in the home country. This change would eventually lead to a complete inversion of the flow of cross-border trade (Vernon 1966). The model was one of the first contributions that related international engagement to technological change by explicitly mentioning the role of demand conditions (Cantwell 1997).

From a micro perspective, another major starting point was the "eclectic paradigm" developed by Dunning (1980). His concept comprised three types of advantages that determine the extent, mode and location of foreign business activities: Ownership (O), Internalisation (I) and Locational (L) advantages. According to this concept, a company only engages in international activity if it obtains certain competitive (O) advantages in relation to other firms, especially those of the host country that it wants to play off in international markets. The other two dimensions answer the question of how to proceed, by keeping the knowledge and expertise in-house (I advantage) or by licencing it out. If the expertise is internalised, the company serve the market from the home base via exports or make use of the locational (L) advantages of the host country.

These models were initially output/outward oriented. Thus, they contributed to an analysis of the international exploitation of technology but pay no or only peripheral attention to the possibility that competitive advantages might be derived and/or sustained through international engagement rather than emerge from the context of internationalisation (Dunning and Wymbs 1999; Granstrand et al. 1992; Shan and Song 1997). Knowledge augmentation (e.g., against adoption) was a key aspect of this strategy of engagement. The underlying observation of these contributions is that there are persistent location differences in an increasingly "globalised economy" that can be explained by the specificities of systems of innovation (SI). The SI literature (Freeman 1987; Lundvall 1992; Nelson 1993; Edquist 1997) explored the impact of the home country's innovation system on firm performance, corporate capabilities, organisational forms, and strategies, and it related these factors to institutional, economic and technological differences in the home base.

In addition, the concept of lead markets as a complementary view to outward-oriented views has gained importance. This concept focuses more on demand factors and links demand conditions with the technological capabilities of countries, and complements the outward-oriented view to create a 'virtuous cycle' leading to innovation (e.g., Beise 2004). In short, the overall economic, institutional (including norms and rules), and political conditions and knowledge capacities in certain locations co-determine both the performance of companies located there and the attractiveness of the location for foreign companies.

This debate on the geography of innovation prompts questions regarding the appropriate level of investigation, with regional agglomerations (clusters) – as opposed to national factors – gaining new momentum as "islands of innovation" within globalised markets (Simmie 1998). Increasing international interconnectedness was seen to be accompanied by growing regionalisation, with these two factors representing two sides of the same coin. As knowledge becomes more complex and differentiated and tacit elements become a part of knowledge generation and transmission, proximity advantages accrue within regional agglomerations. By contrast, highly specialised complementary knowledge and expertise can most likely only be found in few places dispersed over the globe. This state calls for international participation, cooperation and coordination. These persistent location differences are presumed to be an important determinant of internationalisation behaviour in two senses: 1) by contributing to ownership advantages, these location differences cause a firm to internationalise (i.e., the motive of "technology exploitation"), and 2) they create a need to participate in other countries or "pockets of innovation" to make use of foreign locational advantages (i.e., the motive of "technology exploration").

Supplementary to the geographical perspective, the concept of sectorial innovation systems stresses the specificities of innovation system elements and dynamics according to sectorial characteristics and complementarities (technological and market) (Malerba 2002). The literature has recently emphasised (Cantwell and Molero 2003; Narula 2004; Sadowsky and Sadowsky-Rasters 2006; Balcet and Evangelista 2005) that the sector of activity is a central determining factor for the scope and scale of companies' international activities. Thus, to understand how and why firms internationalise their innovation activities, what motivations drive them, to what extent context conditions influence them, and how these factors affect the companies and their environments, we suggest that a combination of the national and sectorial systems of innovation approach be applied.

4.3 Internationalisation of innovation in SMEs

The developments of MNEs have manifold implications for SMEs and for our understanding of their international activities. Most obviously, the changes in the strategies of MNEs have major implications for how SMEs survive and prosper within an increasingly international setting. The effects of MNEs include the following: they constantly challenge existing regional and national network structures,

and they put indirect pressure on SMEs (those that are linked up with MNEs in knowledge and innovation networks) to adjust their own international strategies. Conversely, MNEs also positively affect SMEs by offering opportunities in new markets in terms of knowledge-intensive services and within manufacturing sectors.

The internationalisation of the public research arena in terms of the market for public R&D contracts and partnerships also affects SMEs. Public research can be used to pipeline global knowledge back into the home base country of SMEs. Additionally, as R&D personnel trained in public organisations are increasingly experienced in international activities and linked to international networks, these personnel can also bring global knowledge back home. This effect was confirmed in a German study (Edler et al. 2007), which found that the multitude of contract-performing public research institutes serve the needs of their local clients better when engaged in international activities and that these local clients take advantage of this international activity.

Knowledge about the international activities of SMEs, especially their knowledge and innovation (K&I) activities, is still highly limited. SMEs account for roughly 30 per cent of world exports, which is considerably less than their share in value added or employment. We know that the turnover of SMEs in Europe is increasingly based on exports, with strong national differences. At the same time, companies with a high degree of international activity are more productive and have better employment generation profiles than companies confined to national markets. Although offshoring of production capacity is still more limited for SMEs than it is for MNEs, SMEs have intensified their offshoring activities in recent years, especially in more proximate Eastern European countries (e.g., Kinkel et al. 2007).

A recent large survey undertaken by the SME Observatory (ENSR 2003) also highlights the extent and importance of international activities for SMEs in Europe. It considered the internationalisation of the net value chain (outward plus inward activities), and showed how, compared with large MNEs, SMEs still had less capacity to take advantage of the international dimension, primarily by engaging in cooperation activities.[25] The study demonstrated the enormous increase in international cooperation activities in general. However, despite controlling for sector, size and country, the analysis lacked depth in terms of driving forces, context variables and companies' specificities.

In the same way, cooperation has been regarded as important in innovative Finnish SMEs as well. According to Rilla and Saarinen (2008), quickly internationalising innovative companies develop radical innovations and also have more

[25] One shortcoming of the study is that the authors only distinguish between four modes of international engagement: (1) import through foreign suppliers, (2) export activities, (3) cooperation activities with foreign SMEs and (4) foreign subsidiaries or joint ventures. Thus, they disregard many supplementary channels for international K&I sourcing and exploitation (especially indirect means) as well as other potential foreign cooperation partners, such as the international science base and foreign large MNEs. To obtain a conclusive picture that approximates real phenomena as effectively as possible, more in-depth analysis is needed.

cooperation with foreign partners compared with companies that have developed less novel (i.e., incremental) products. In contrast, a study of SMEs in Northern Britain indicates that, even though cooperation with certain actors has positive associations with innovation success, a large number of successful innovators did not cooperate to innovate (Freel and Harrison 2006). However, these results are contradictory and provide only a partial view on the usage of foreign knowledge in innovation.

With regard to innovation activities, systematic data are scarce. For European SMEs, the Community Innovation Survey (CIS) has one important piece of basic data (i.e., the share of innovative companies that engage in international cooperation [EU Commission 2004]).[26] This study shows that European SMEs generally cooperate much less than larger companies, especially internationally.[27] The low level of international cooperation by SMEs in K&I could be a limiting factor for their future innovative capacity, as there is a strong association between successful innovation activity and cooperation (EU Commission 2004). If we accept the premise that international knowledge is becoming increasingly important, an analysis of patterns and hindrances for international cooperation among SMEs is clearly important in both conceptual and policy terms. Equally, although some studies now claim that foreign locations are being increasingly tapped by SMEs as they face a need to participate in global K&I production and distribution (e.g., Boutellier et al. 2000), it would be misleading to expect them to be driven by the same motives and to be able to internationalise in a similar manner as large MNEs, as the resources and capability endowments of SMEs differ from those of larger companies. SMEs may also be constrained by the high and increasing costs of search and negotiation because of their weaker and smaller international networks (OECD 2008).

International activities in SMEs

As argued previously, little is known of SMEs' foreign K&I activities. This lack of knowledge is also reflected in the internationalisation literature. Most of the current studies on SME internationalisation are process-oriented, empirically driven and focused on the firm's export behaviour. International activities are initiated on the basis of existing competitive advantages, with firms aiming to exploit them in international markets. Various modes of internationalisation and models that explain them exist. At one end of the spectrum, there are international entrepreneurs and international start-up companies with global models from the outset. These companies develop their businesses and identities on a global scale from the begin-

[26] Unfortunately the CIS does not reveal the location of knowledge sources when asking companies for the importance of various knowledge sources.

[27] However, there are considerable differences between the companies of different home countries. As Castellacci (2006) argues, the large differences across countries are due to the influence of national innovation systems and to the interaction between national systems and sectorial patterns of innovation.

ning. At the other end, some SMEs are entirely nationally oriented in all of their value chain activities and market opportunities. At this stage, some well-established models seem appropriate for analysing SME internationalisation in the context of innovation activities.

The first such model is the Uppsala model, which was introduced by Johanson and Wiedersheim-Paul (1975) and subsequently expanded by Johanson and Vahlne (1977; 1990). This model sought to explain the internationalisation process of large firms.[28] However, it was subsequently shown that this process model had a wider applicability in that it could predict the international behaviour of SMEs. The authors distinguished among different modes of entry in an international market, with successive stages of expansion representing higher degrees of international involvement. The establishment of overseas production units represented the final state. To explain the internationalisation process across national markets, they hypothesised that firms entered new markets with successively greater "psychic distances".

However, the internal activities and strategies of the firm during the internationalisation process were completely ignored by the process model construct (Welch and Luostarinen 1988; Korhonen et al. 1996). In fact, as a study conducted by Korhonen et al. (1996) revealed, the majority of internationalisation activities initially engaged in by companies were classified as inward rather than outward actions. In addition, a later study performed by Fletcher (2001) indicated similar results. This type of holistic approach, which considers both inward and outward movements, is well suited to analysing the internationalisation of SMEs, particularly entrepreneurial firms whose operations are not as formal as those of larger firms. Companies might actually start their international operations with imports of technology, which are regarded as inward operations. According to Luostarinen (1994), internationalisation is considered to be a two-way process consisting of two processes that proceed in tandem.

In addition to the exploitation of K&I, "knowledge augmentation" strategies have received scant attention within SME internationalisation studies. Compared to MNEs, there may be diverse motives pushing and pulling SMEs abroad, as well as various channels to international markets that depend, for example, on size, sector/technology and status within the overall value chain. Possible tactics include recruiting personnel with specific knowledge and personal networks to external knowledge carriers, acquiring companies with specific knowledge and customers as well as suppliers with related external knowledge, or collaborating with external organisations with specific knowledge. The knowledge augmentation can be seen as an inward activity that aims to acquire knowledge in-house, with formal (or

[28] For example, the large Finnish pharmaceuticals company Orion Ltd had three stages in its internationalisation process: Stage 1: globalisation of market presence (contributes to growth), Stage 2: globalisation of manufacturing operations (contributes to efficiency) and Stage 3: globalisation of R&D activities (contributes to innovation). Source: A Slide presentation of Orion Corporation (2006).

informal) means that would qualify as inward activity in Luostarinen's (1994) internationalisation model.

Equally, the "stagist" process models were often challenged by empirical evidence as new forms and models of international organisation and networking were revealed. Oviatt and McDougall (1994) reported and analysed another type of firm called an "International New Venture" (INV) that uses resources from abroad and/or exports its goods and services in an early stage of the company's life. According to them, these companies seem to be highly aware of the need to exploit international market opportunities since their inception. In other words, these companies internationalise rapidly since the initial stages of the company life cycle (Oviatt and McDougall 1994, Madsen and Servais 1997, Jones and Coviello 2005). The desire to operate in global niche markets drives many high-technology firms (e.g., in ICT or biotechnology). Being global is necessary because of the limited or non-existent opportunities in the domestic environment and because these born globals need to amortise their high R&D costs across a wide customer base as soon as possible.

By contrast, some SMEs might be entirely nationally oriented in all of their value chain activities and sales. In general, SMEs cannot be as flexible as MNEs when exploring opportunities abroad. The costs of starting and increasing international activities are higher (in relation to turnover or capital), and the risk management is therefore more challenging. SMEs are less likely to engage in FDI than larger firms, and cooperation is thus a preferred option. However, improvements in communications within the last two decades have opened up new possibilities for a large number of SMEs to become more directly engaged in international K&I activities without fully relaxing the resource constraints experienced by many SMEs.

In addition to process theories in internationalisation, complementary insights could be gained from social theory, namely the "markets-as-networks" perspective introduced by the Stockholm School of Economics. This theory assumes that a firm is embedded in a wider, dynamic, interconnected and co-evolutionary context that determines the firm's freedom of choice to a certain extent. The network approach further suggests that a company's internationalisation behaviour is reliant on the network to which it already belongs and builds in the international market, as well as how it positions itself in these networks (e.g., Johanson and Mattsson 1988; Keeble et al. 1998). Furthermore, the strategic actions by one firm can initiate changes in the whole network structure (Fletcher and Barrett 2001). Thus, internationalisation is not merely a self- and strategically determined process; rather, it is also often contextually contingent on nature, as internationalisation is dependent on contextual factors (Turnbull 1987; Welch and Luostarinen 1993; Fletcher 2001) and existing network partners play an important role in determining the pattern of international engagement by firms (Coviello and Munro 1995). This holistic approach leads to a more complex understanding of internationalisation behaviour and is therefore presumed to be better capable of explaining the international activities of SMEs. Networks enable a high degree of participation in international activities without requiring ownership of foreign assets by acting as a pipeline to the wider world. Although the network approach bases its arguments

on international process models, the evolution of relations with network actors are the focus of the studies. The relationships, which may concern innovation networks (e.g., Ahuja 2000; Pittaway et al. 2004), business networks (Håkansson and Snehota 1995), or start-up and entrepreneurial networks (e.g., Coviello and Munro 1995; 1997), form an important base for a company's operations.

According to Partanen (2008), a firm in an early growth phase typically has only one international distributor, and the search for distributors usually adaptively follows the opportunities opening up to the firm. In their early phases, firms also acquire customers and create credibility by constructing partner and customer networks. Partanen (2008) distinguished between partner customers, pilot and leading customers, and basic customers. Partner customers can be commercialising or developing partners or system integrators. Independent R&D partners and market-based partners play often a pronounced role in the early growth phase. Partner customers provide SMEs with cash flow, knowledge and capital for product development, and references. They also provide an opportunity to focus on a few markets and to build up a balanced customer base and offering. In many cases, basic customers also provide SMEs ideas for product development. However, one challenge is determining how to integrate the customers into the product development.

In summary, we know by now that major MNEs are not entirely bound to merely national K&I activities. Rather, they have high degrees of freedom in engaging, sourcing and distributing knowledge on an international scale and make use of this freedom quite extensively. In addition, it is well documented that changes in the supplier chain strategies and competition implemented by MNEs have a strong bearing on SMEs and their possibilities to survive in these circumstances, depending on the forecasting abilities of SMEs.

5. Approaches to open innovation and external knowledge sourcing

The innovation literature has long recognised that companies do not innovate in isolation but cooperate with external partners throughout the innovation process. The emphasis on open innovation primarily reflects the greater awareness of innovative activities (technological and non-technological) across firm boundaries that an organisation obtains with a more equal balance of internal and external sources (Acha 2007). The novelty of the open innovation concept, coined by Chesbrough (2003), lies especially in the fact that the open innovation process has become an integral part of companies' innovation strategies and business models.

> Open innovation is "the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively" (Chesbrough et al. 2006). Open innovation includes three processes: inside-out, outside-in and coupled processes (Gassmann and Enkel 2006).

Innovation models reflect the changes that have taken place in innovation management. The centralised closed organisation of R&D was the dominant model at a time (1950–1970) when innovation management was shaped by the technology-push view. At that time, R&D, with strong specialisation and autonomous R&D professionals, was assumed to be the main driving force of innovation, and innovation activities took place in R&D laboratories that were relatively isolated from business problems and other corporate activities (Roussel et al. 1991; Coombs and Richards 1994; Lam 2000).

Since the 1980s, firms have tended to outsource a larger part of their R&D, which reflects the market-pull view of innovation. The decentralisation of R&D to business units and the formation of a market relationship between R&D (as supplier) and business divisions (as customer) are characteristics of this type of organisation. Today, innovation is no longer an autonomous activity driven primarily by R&D experts but is increasingly integrated in the firm's business and organisational context. Furthermore, to develop new technologies and knowledge beyond the firm's core competencies, both internal and external networks of interaction are set up. Innovation is perceived to be cross-functional and transdisciplinary,

and access to a wide variety of external knowledge sources is regarded as crucial for generating innovations, especially radical innovations. The recent innovation models try to incorporate more complexity and interaction into the framework and explicitly stress the need for openness towards external partners in innovation and R&D (OECD 2008).

While open innovation examines the innovation system from the company's perspective, the literature on innovation systems looks at companies as black boxes. The concept of an "innovation system" (including customers, suppliers, competitors, universities, and government organisations) was first launched by Lundvall in 1985 (Lundvall 1985). It viewed innovation as a "social" process involving a multitude of interactions among various parties.[29] Shared practices, attitudes, expectations, norms and values, which facilitate the flow and sharing of tacit and other forms of proprietary knowledge, are considered to be crucial to the innovation system. Innovations result from interactive processes of development and learning across organisational boundaries because scientific and technological developments largely arise through the interplay with other sources of knowledge (OECD 2008).

Concepts such as open innovation and innovation systems build on the recognition that inter-organisational linkages are critical to the innovative capabilities of firms and the growth of economies (Herstad et al. 2010). MNEs are increasingly linking up with start-ups, spin-offs and the public R&D system. Indeed, companies' boundaries are becoming a semi-permeable membrane that enables innovation to move more easily between the external environment and the companies' internal innovation processes. National/regional systems of innovation emphasise these inter-organisational linkages as the basis for knowledge creation and diffusion and have been highly influential as a basis for policy development (Lundvall 1992; Nelson 1993).

The empirical literature on external knowledge sourcing (in the open innovation terms, outside-in process or inbound innovation) is vast and includes discussions on the importance of technology sourcing as a motive for FDI, of the appropriate choice of modes and partners in accessing external knowledge, and of the complementarity between internal and external R&D and knowledge (i.e., absorptive capacity)[30] (e.g., Dahlander and Gann 2010; Enkel et al. 2009). Empirical research on the inside-out process (outbound innovation) is much more limited (e.g., Lichtenthaler 2009). Research on corporate venturing (spinning off and spinning out) has only recently started to develop. The coupled process of open innovation (e.g., R&D co-projects and strategic alliances) is partially covered by the growing

[29] The term "innovation system" refers to the operations and interaction of universities, research institutions, other public organisations, and private businesses, which together influence the creation, diffusion and utilisation of knowledge (Ali-Yrkkö 2010, p. 20).

[30] Cohen and Levinthal (1990) defined absorptive capacity as 'the ability to recognise the value of new information, assimilate it, and apply it to commercial ends'.

literature on joint ventures, alliances and networks (Gassmann and Enkel 2004; Enkel et al. 2009).

Open innovation concepts:

- The outside-in process: sourcing and integrating the external knowledge of customers, suppliers, universities and research organisations, competitors, and other actors; screening for innovative ideas and acquiring knowledge (e.g., licensing in).
- The inside-out process: bringing ideas to market, selling, licensing intellectual property out, multiplying technology, and revealing knowledge (e.g., open source software).
- The coupled process: combining the outside-in and inside-out processes, working in alliances with complementary knowledge, and engaging in co-creation (e.g., R&D co-projects and strategic alliances).

The Netherlands Advisory Council for Science and Technology (AWT 2006) developed a slightly different typology on open innovation by distinguishing between purchasing-based open innovation, collaborative (open) innovation and open access innovation (open development model). These dimensions differ mainly in terms of the coordination mechanisms between economic actors. In so-called purchasing-based innovation, companies interact with other parties as they purchase inputs for their innovation processes. Collaborative innovation implies that companies set up partnerships to innovate together in pursuit of a common goal. Companies in open access innovation allow anyone to contribute to the innovative process (e.g., users, employees, and suppliers) (OECD 2008).

With the rapid shift in industry and technology borders, new business opportunities arise, implying the need for new business models to exploit these opportunities. Chesbrough (2003) mentions the so-called erosion factors. These are global competition, shortened product life cycles, the increased complexity of new technologies and knowledge, the increasing costs and risk of innovation, the supply and mobility of researchers and engineers, the supply of venture capital for innovation, and the capabilities of actors in the global value chain (OECD 2008).

(Global) innovation may also be directly related to the concept of technological regimes (Nelson and Winter 1982), which are determined by differences in knowledge conditions such as appropriability, opportunity and cumulativeness (Malerba and Orsenigo 1993). Chesbrough and Teece (1996) report that in practice, most companies use a mix of approaches: they 1) purchase some technologies from other companies, acquire others through 2) licences, 3) partnerships and 4) alliances, and develop still other critical technologies 5) internally.

Open innovation also has disadvantages, especially because technology and innovation have often become the basis for companies' competitive advantages. The academic literature on cooperation, collaboration and alliances has discussed various disadvantages: the extra costs of managing cooperation with external partners, the lack of control, the adverse impact on flexibility, the (over)dependence on external parties and the potentially opportunistic behaviour of partners (OECD 2008).

5.1 Open innovation in global networks

Companies increasingly look for partners with complementary expertise to obtain access to different technologies and knowledge quickly. Although companies also increasingly innovate within innovation networks in which links and connections among innovation partners have become as important as the actual ownership of knowledge, investment in internal R&D is still necessary because of the importance of absorptive capacity (Cohen and Levinthal 1990).

International innovation networks include their own R&D facilities abroad, collaborative arrangements and other external innovation sources. Therefore, open innovation is broader than pure outsourcing of innovation activities to external partners. In addition, joint ventures, acquisitions and venture capital are increasingly used for innovation and are not necessarily considered in R&D budgets. The concept of open innovation draws attention not only to the importance of knowledge sourcing but also to the exploitation of internal innovation together with external partners (the so-called inside-out process). This complex and more open way of innovating requires cross-functional cooperation and interaction among the various departments within companies, including R&D units, manufacturing, marketing sales and services, as well as enhanced interaction with both public and private external parties (OECD 2008).

The innovation networks of MNEs create cross-border nodes between regional/national systems of innovation. MNEs also link S&T (Science & Technology) actors in different countries, and their networks often span clusters and industrial districts in their search for new knowledge because they recognise that spillovers often occur as a result of geographical proximity. In this context, geographical proximity permits localised learning. Thus, the attractiveness of (global) open innovation depends on the technological and industrial context (Chesbrough 2006). The model is perhaps most prevalent in the ICT (Information and Communication Technology) sector. However, open innovation is also found in industries such as pharmaceuticals, with active technology in-sourcing from biotechnology start-ups. While large pharmaceutical companies maintain significant in-house research capabilities, they are progressively relying on externally sourced compounds to widen their product lines (OECD 2006).[31]

A Dutch report on open innovation (AWT 2006) highlighted the need for speed because global competition forces companies to innovate more quickly and more efficiently. Technological advances, notably in ICT, have facilitated cooperation among actors in the innovation process. Globalisation is a major driver of more open innovation processes because it not only generates more intense and global competition but also creates a more global landscape for innovation.

[31] The degree of openness differs among innovation types. For instance, in the chemicals, steel, railroads and petroleum industries, which are characterised by long product life cycles, high capital intensities, and systemic innovations open innovation is less attractive (OECD 2008).

In this study, we divide cross-border knowledge sourcing into the following:

1) international sourcing, where knowledge-intensive corporate functions are internationalised and research and development facilities are located abroad,
2) opening up of innovation processes to collaboration with external partners (e.g., contractual agreements, alliances, joint ventures, joint development, contract R&D, purchasing, financial arrangements, corporate venturing, divestments, and spin-offs),
3) other external sources of technology and innovation, external ideas and knowledge (e.g., patents, co-inventions and co-applications, and licensing agreements).

5.2 SMEs in international innovation networks

To summarise the implications for this study from the previous discussion on the internationalisation of K&I activities, we can observe that these activities are increasing in scale and scope. Thus, the growth and competitiveness of firms and innovation systems depend on how systematically different actors can integrate and shape this internationalisation process. Although MNEs account for the bulk of global R&D expenses and international activities, the increasing number of strategic international SMEs can affect their own innovation activities as the major providers of value added and employment. This effect is especially relevant in the context of rapid internationalisation by both MNEs and public research organisations. This new environment exerts greater pressures on and provides new market opportunities for SMEs.

The significance of external knowledge to innovating companies and the short overview on the international K&I activities of SMEs highlight important gaps. We know too little about the specific activities, challenges, and benefits of SMEs in terms of generating or sourcing (or co-generating) external market and technological knowledge internationally. Moreover, we know little about how international knowledge can be best used for the innovation process of companies. As a consequence, there is a decision-making knowledge gap both in business and policymaking. The leverage of public policy at all levels could be greatly improved if we knew more about the international activities and specific needs of SMEs to best exploit and contribute to the international arena.

Finally, there is a gap in the academic knowledge in existing models for describing and predicting the K&I behaviour of international SMEs in certain circumstances. The existing models (e.g., the resource-based or behavioural models) typically do not fit with the characteristics of SMEs or of their innovation processes. Originating from Penrose (1959), the resource-based view of the firm provides an approach to study companies' reasons for engaging in interaction or networking with other firms, whether domestically or internationally. It emphasises firms' heterogeneity in absorbing, cumulating and exploiting knowledge resources. Thus, competencies are mostly firm-specific and path-dependent, and they reside tacitly in the employees' hands and heads, the organisational structure, the procedures

and the corporate culture (Nooteboom 1999a). Specialisation in certain resources makes the firm dependent on other firms for complementary assets. Consequently, the firm needs to enhance its attractiveness as a network partner by enhancing its competitive advantage.

In contrast, behavioural theories (see, e.g., Nelson and Winter 1982) stress the impact of the choices made by firms on their success. Institutional theories (see, e.g., Scott 1995; Geels 2004) underline the firm's connections, its environmental institutional structures and the enabling or hindering effects of these structures on business success. There are many levels in these structures, such as regulatory, normative, culturally cognitive or technological structures.

De Clercq et al. (2005) assume that higher entrepreneurial activities enhance the internationalisation or the intensity of international activities such that the conventional internationalisation theories are no longer valid. Additionally, Sapienza et al. (2006) point to the impact of the entrepreneurial orientation on the cumulative learning in internationalisation (Autio et al. 2007).

Furthermore, we can posit a hypothesis that, for SMEs (especially micro firms), accessing global knowledge flows typically necessitates interlinking with other firms (i.e., becoming either a group member or, in certain cases, partnering or collaborating with other firms). Recruitment and supporting services can also act as a remarkable channel into external knowledge.

Technology networks play a crucial role in a company's international operations. According to Partanen (2008), in addition to customers, the so-called key suppliers also provide R&D knowledge, and agents are used by SMES to search for new partner customers and to construct a network for market channels. Market-based tacit knowledge is acquired via cooperative rings, open discussion forums and joint offering networks. Partanen (2008) also found that the science- and knowledge-based SMEs do not seem to create their business concepts purely based on networks; the conventional market relations (transaction suppliers, service suppliers) are the most often used organisation forms supporting the purchasing-based open innovation model. Further, the multi-actor networks (i.e., strategic business networks) were comparatively rare. The horizontal networks containing the present and potential competitors were quite rare as well.

6. The global openness of Finnish innovative SMEs

The aim of this chapter is to describe the status of international knowledge and innovation activities in Finnish innovative SMEs and innovation systems.

Some information regarding open innovation – cooperation for innovation

According to the Finnish Community Innovation Surveys (CIS), approximately 60% of innovative SMEs cooperate for innovation with other firms, and approximately half of these firms cooperate internationally. The number of international collaborators among innovative SMEs has prominently increased since the launch of the first CIS in Finland. In CIS, collaboration is defined as the "active participation in joint innovation projects with other organisations" (OECD 2007a). It excludes pure contracting out of work. Therefore, more direct evidence on open innovation, particularly the sourcing of innovation (i.e., the outside-in process of open innovation), has to be derived from other surveys.

According to CIS, companies collaborate for innovation most frequently with suppliers and customers; cooperation with competitors, private R&D labs and consultants seems to be somewhat less important. International technology collaboration (i.e., collaboration with foreign partners) is found to play a prominent role in companies' innovation processes, but geographical proximity still seems to be valued. Again, SMEs seem to be less active in international collaboration for innovation than larger companies. Collaboration with external partners on the international level requires extra investment and resources. SMEs have limited resources in selecting the right partner and therefore higher opportunities to fail compared with larger actors. This fact explains why SMEs, with their typically fewer resources, display fewer tendencies to collaborate with external parties both internationally and overall. Because international partnerships are more costly and difficult to manage, companies enter them if they are strongly motivated by market demand or the search for excellence.

Additionally, the database on Finnish Innovations (Sfinno) provides evidence that collaboration is an important action for innovation among Finnish companies. The database includes information on whether an innovation development involved collaboration and the status of the collaborators (e.g., domestic/foreign universities and domestic/foreign customers). In addition, there is information

about the significance of this collaboration for innovation development. Out of the 1038 observations (i.e., innovations), 915 involved some type of collaboration. An interesting result for this study is that 84 per cent of innovations (N = 939) involved a foreign collaboration partner. This finding clearly indicates that the procedures of international knowledge sourcing should be investigated more thoroughly.

Some information regarding open innovation – the share of internationally sourcing firms

According to the International Sourcing Survey, the largest share of enterprises that have sourced internationally is found in Denmark (19% of all firms with 50 or more employees), followed closely by Finland (16%), Norway and the Netherlands (14%) (Statistics Denmark 2008).

Contracting an unaffiliated supplier abroad is not typical for Finnish large- and medium-sized firms. In Finland and the Netherlands, enterprises often rate access to new markets as an important reason for international sourcing. Typically, enterprises consider offshoring to have a major positive impact on their overall competitiveness.

The main business function sourced abroad is the core function, but support functions are sourced abroad to some extent. In Denmark and Finland, the share of firms that have sourced R&D internationally is 15% of all internationally sourcing firms. More than half of all international sourcing activities are located within the EU, mostly in the new EU Member States. A fourth of all offshoring activities in these countries use Asia as the destination. The main model of offshoring is in-sourcing (i.e., sourcing within the same enterprise group).

According to the Finnish data, only a few SMEs have outsourced R&D activities to other companies abroad or relocated their R&D to affiliates of their own groups abroad. Among these firms, technical service firms represent the largest group. Collaboration is much more actively used as an international knowledge sourcing strategy among SMEs. It is therefore relevant to examine large MNEs that have outsourced or relocated their R&D activities abroad and their domestic SME suppliers and group members. Collaboration with such MNEs can be considered to be one type of international K&I sourcing strategy. Therefore, knowledge flows in terms of recruited personnel from MNEs to SMEs (captured from the Employer-Employee data) can have an international sourcing dimension, as discussed in Section 7.

Imports of R&D services, royalties and licences can also be used as an indicator of international K&I activities. In 2007, the number of SMEs that have imported these K&I services was 400. On average, a firm is sourcing technological and other types of knowledge from four different countries (source: Statistics Finland, International Trade of Services).

Some information on internationalisation – the host countries for overseas R&D among the largest Finnish companies

Information on MNEs conducting R&D activities abroad can be based on some special ad hoc surveys, such as the KEI (Knowledge Economy Indicators) Pilot

Survey on outward R&D activities among the 30 largest Finnish groups of companies. The KEI Survey was undertaken by Statistics Finland in 2006. According to this survey, the most significant countries in terms of Finnish companies' overseas R&D are the United States, Germany, the United Kingdom and Sweden. Only 5 per cent of all outward R&D is located in Asia and Australia. According to this study, the most important motives for internationalising R&D activities are demand-side factors. Providing support to local production and marketing is ranked the highest among all motives for conducting R&D abroad. Additionally, good availability of skilled R&D personnel is seen as an important (supply-side) factor (Luhtala and Åkerblom 2006).

6.1 Internationalisation of K&I activities

In this study, the internationalisation of knowledge and innovation activities among Finnish SMEs is investigated more thoroughly via a pilot survey. This study provides more detailed information on K&I sourcing than any existing data. The survey includes specific questions on the innovation knowledge sourcing practices (mechanisms) in SMEs. The response rate in this survey was 22 per cent (139/630). Before examining the results of the survey, we first look at the population and sample of the respondent firms.

The population of innovation-active SMEs in Finland

In this study, the population of Finnish innovation-active SMEs is drawn from 7 large data sets on firms' R&D, innovation and patenting activities (i.e., all of the R&D and Innovation Surveys conducted by Statistics Finland in 1991 to 2006 [2008], the Database of Finnish Innovations [Sfinno] maintained by VTT, the data on firms' Tekes customership, and the data on firms' patenting activities in the US Patent and Trademark Office [USPTO], in the European Patent Office [EPO] and in the National Board of Patents and Registration of Finland [NBPR] over the period of 1985–2006).

Based on the R&D Surveys and Business Register, the total non-weighted number of R&D-performing firms operating in 2008 is 7,179. Based on the CIS Surveys, the total number of innovative firms operating in 2008 is 5,297. The Sfinno Database includes information on 1,667 operating innovative firms, and there is information on 4,671 firms that have been in a customer relationship with Tekes and that still operated in 2008. From 1985 to 2006, the data provided by the NBPR include the names of 4,971 firms that have domestically applied for a patent, the EPO patent data include the names of 1,767 Finnish firms that have applied for a patent in EPO, and US patent data include the names of 1,088 Finnish firms that have been granted a patent by the USPTO.

The number of all firms and SMEs operating in 2008 in the biotechnology, medical devices, mechanical engineering, consumer electronics and technical services sectors in these data sets are described in Table 5.

Table 5. The number of firms and SMEs operating in 2008 in the target sectors.

Data sources	N of firms surviving in 2008	N of SMEs in target sectors
R&D Surveys	7179	884
CIS Surveys	5297	597
Sfinno database	1667	187
Tekes clients	4671	621
NBPR	4971	589
EPO	1767	233
USPTO	1088	130

According to the data sources given above, the total number of innovation-active SMEs is 1,362, of which 1,147 firms employed at least one person and 793 more than five persons (see Table 6).

Table 6. The number of innovation-active SMEs in the target sectors.

Sector	N of innovation-active SMEs in target sectors
Biotechnology	107
Mechanical engineering	488
Consumer electronics	72
Medical devices	59
Technical services	653

It is noteworthy that a firm can simultaneously belong to the biotechnology sector and to the medical devices or technical services sector. In other words, the sectors are partly overlapping.

Foreign-owned firms and some non-active (in 2009) firms were excluded from the data, as were the firms established before 1990 according to the Business Register. After this phase, we searched for the contact information of these firms. The email or web domain addresses were found for a little more than 700 SMEs. When the firms not reached and firms that refused to answer were excluded from the list, we ended up with 630 SMEs in our target sectors.

Respondent firms by sectors

The total number of respondent firms is 139, and the response rate is 22%. Four of the respondents belong simultaneously to biotech firms and medical devices or technical services firms. Hence, the total number of unique firms is 135. According to the Business Register data among the 11 biotech firms, five firms belong to R&D services, and three conduct technical testing.

Table 7. The number of SMEs and response rates by sector.

Sector	Responded	Unweighted Population	Response rate
Biotechnology	11	59	19
Mechanical engineering	39	174	22
Consumer electronics	11	48	23
Medical devices	4	29	14
Technical services	74	320	23
TOTAL	139	630	22

As shown in Table 7, the number of respondent firms is quite small in the medical devices, biotechnology and consumer electronics sectors. Accordingly, these sectors cannot be systematically compared with others based on the responses. Therefore, in the following, we mainly compare the mechanical engineering and technical services sectors.

Except for the low number of respondent firms in some of the sectors, there is one more shortcoming in the sample of respondent companies: the companies belonging to enterprise groups responded poorly. Only nine (7%) of the respondent firms belong to enterprise groups. Three of them are group parents, 4 are daughters, and 2 are intermediate parents. In the population of innovative SMEs, this share is 23%. It is likely that the respondents perceived the questions as strategic ones such that the group parents could have replied to them. Otherwise, the sample of respondent firms reflects the target population of innovation-active SMEs in the selected sectors surprisingly well.

In summary, independent SMEs in technical services and mechanical engineering are well represented in the sample of respondents. It follows that these sectors can mainly be compared on the basis of the responses. The share of companies in these groups in terms of certain classifying factors[32] is the same or approximately the same as in the population.

[32] In the population of innovative SMEs, the share of firms with export activities (according to Business Register) is 46 per cent, and that of high-growth firms is 27 per cent. The corresponding figures among the respondents are 42 per cent and 25 per cent, respectively.

Size classes

More than 70 per cent (97) of the respondent firms are micro firms with fewer than 10 employees, and two-thirds (90) are micro firms with fewer than 5 employees. Only 9 firms had two or more establishments. Six out of the 11 biotech firms are micro firms with fewer than five employees. In 2008, the average number of employees in the response group is 12.6 persons, while the median is 2.8. The average turnover in the same year is EUR 2.1 million and the median turnover EUR 290 000. As a whole, the respondent SMEs constitute a fairly representative sample for the population of innovation-active SMEs in the target sectors. (See Table 8.)

Table 8. The number of SMEs and response rates by size class.

Size class	Responded	Unweighted Population	Response rate
Less than 5 employees	90	401	22
5-9 employees	7	37	19
10-19 employees	15	63	24
20-49 employees	12	79	15
50-99 employees	8	29	28
100-249 employees	3	21	14
TOTAL	135	630	21

Spin-offs

There are 30 firms (22%) that classified themselves as spin-offs of some existing organisations. In approximately half of these spin-offs, business activity was substantially based on an invention developed in the parent or another organisation (e.g., company, research institute, and university) or on knowledge absorbed from this organisation. In addition, there are 17 companies that stated that they are not spin-offs but that their business activities are based on inventions or knowledge absorbed from another organisation. Together, 45 (i.e., one-third of the companies) responded that their business activities are based on an invention developed in another organisation or that they are spin-offs for this or for some other organisation. In this respect, only two-thirds of the respondent companies are independent. (See Table 9.)

Table 9. Background information of the respondent firms in the five sectors.

(% of respondents)	Biotechnology	Mechanical engineering	Consumer electronics	Medical devices	Technical services
Spin-offs	54.4% (Universities of Tampere, Turku, Helsinki and Oulu; private firms).	28.2% (private firms).	45.5% (over ¾ from VTT).	75% (Tampere University of Technology, private firms).	17.3% (13.3% from the private sector).
Age	63.6% established before 1999.	64% established before 1999.	45.5% established before 1999.	All firms established before 1999.	58.7% established before 1999.
Size	Micro companies 63.6%.	Micro companies 38.5%.	Micro companies 81.8%.	Micro companies 75%.	Micro companies 88%.
Number of respondents	11	39	11	4	74

Ownership and legal form

All firms in the respondent group are domestically owned. With regard to their legal form, one company is a sole proprietorship (a person company), four are limited partnerships, and the other 130 are limited companies (Ltd's).

Patenting and collaboration for innovation

According to the data provided by the National Board of Patents and Registration of Finland (NBPR), 38 per cent of firms had applied for domestic patents in both the population of innovation-active SMEs and the group of respondent SMEs. In the population of innovative biotech SMEs, 52 per cent of firms had applied for patents, and the corresponding share was even higher among the respondent biotech firms at 64 per cent. According to the EPO data, 16 per cent of the respondent firms had applied for EPO patents, and 8 per cent had received patents from the USPTO.

According to the CIS, the share of firms collaborating for innovation with a foreign partner was 12 per cent in the population of innovative SMEs in the target sectors and 7 per cent among the respondent SMEs. Again, biotech firms outperform other firms in collaboration: in the population of innovative biotech SMEs, 23 per cent of the firms collaborate for innovation, while among the respondent innovative biotech firms, only 9 per cent do so.

Innovation activity of SMEs

According to the background information based on some outside sources (e.g., the Community Innovation Surveys and patent registers), all 139 respondent firms

are innovative or patenting firms. However, only 122 of these firms replied that they engaged in innovation activities from 2006 to 2008 or earlier. In the following, only those firms that had innovation activities at least once over their life cycles will be considered. The number of these innovation-active firms in the response group is 119, of which 115 are different firms.

The majority (68) of these 115 firms belong to technical services. The second largest group (27) consist of mechanical engineering companies. The third largest group is composed of biotech companies (11, with 4 duplicates, i.e., companies that are also medical devices or technical services firms). The consumer electronics sector has 10 innovative companies in the response group, while the medical devices sector has only three of them. (See Table 10.)

Table 10. The number of innovative SMEs by sector and size class.

Sector	Size class						
	0-4	5-9	10-19	20-49	50-99	100-249	TOTAL
Biotechnology	6	1	1	2	1		11
Mechanical engineering	9	3	5	5	4	1	27
Consumer electronics	7	2	1				10
Medical devices	2				1		3
Technical services	59	2	6	1			68
TOTAL	83	8	13	8	6	1	119

High-growth SMEs

The share of high-growth firms in the population is 27 per cent; the corresponding share among the respondent firms is 25 per cent. The total number of high-growth enterprises among the innovative firms is 32 (with 2 duplicates). The populations of electronics and biotech firms have the highest shares of rapidly growing companies at 48 and 34 per cent, respectively. In the sample of respondent electronics and biotech firms, the share of high-growth companies is 36 per cent (4 out of 11).

The share of high-growth SMEs among the respondent innovation-active firms is 40 per cent (4 out of 10) in consumer electronics, 30 per cent (15 out of 68) in mechanical engineering, and 22 per cent (8 out of 27) in technical services. All three medical devices firms are high-growth firms according to our criteria. (See Table 11.) Most of the growth bursts took place around the years 2005–2007, when half (15) of the high-growth firms in the sample were growing more than 20 per cent in their turnover. In 2008, nine firms grew quickly. Most of the 30 high-growth firms were established in the 1990s. It follows that their growth bursts typically occurred not during their early phases but in a later period, when they were 5 to 15 years old.

Table 11. The number of high-growth innovative SMEs by sector and size class.

Sector	Size class						
	0-4	5-9	10-19	20-49	50-99	100-249	TOTAL
Biotechnology	2	1			1		4
Mechanical engineering	3	2	2		1		8
Consumer electronics	2	2					4
Medical devices	1				1		2
Technical services	11	1	1	1			14
TOTAL	19	6	3	1	3	0	32

Internationally operating innovation-active SMEs

According to the Business Register, slightly less than half (46%) of the innovation-active SMEs in the population are exporters or importers. The corresponding share among the innovative biotech SMEs is 58 per cent. The share of firms that have international activities (a research question) is 42 per cent among all respondent firms and 64 per cent among the biotech firms. According to the background data, 19 firms in the response group are exporters, 12 firms are importers and 25 firms are both exporters and importers.

According to the survey responses, two-thirds (78 firms, 3 duplicates) of the innovative SMEs conducted international business activities from 2006 to 2008, with the corresponding share being 70% (21 firms) among the innovative high-growth SMEs. Thirty per cent (9 firms) of the high-growth SMEs had no international operations.

Among the innovative micro-firms, 46 firms (56%) had international business activities. The majority (29) of the internationally operating micro-firms and of all SMEs (37) belong to technical services. Approximately 55% of the respondent technical service companies operate internationally. The SMEs (N = 21) in the mechanical engineering sector comprise the second highest group among the internationally operating innovative SMEs in the response group. Approximately 78% of the respondent SMEs in the mechanical engineering sector are international. Among the internationally operating SMEs, there are also 10 biotech companies and 7 companies in the field of consumer electronics. In other words, 10 out of 11 biotech companies and 7 out of 10 consumer electronics companies stated that they have international business activities.

Table 12. The number of internationally operating innovative SMEs by sector and size class.

Sector	Size class						
	0-4	5-9	10-19	20-49	50-99	100-249	TOTAL
Biotechnology	5	1	1	2	1		10
Mechanical engineering	6	1	5	4	4	1	21
Consumer electronics	4	2	1				7
Medical devices	2				1		3
Technical services	29	2	5	1			37
TOTAL	46	6	12	7	6	1	78

In the group of innovative SMEs, there are 37 (45%) micro-firms with fewer than five employees that only operate domestically. Again, the majority (30) of them and of all SMEs (31 out of 41) belong to technical services. There are six companies in the mechanical engineering sector and three in the consumer electronics sector that had no international activities from 2006 to 2008. Among all respondents, there are no medical devices companies in the group of non-international SMEs and only one among the biotech companies. (See Table 12.)

Innovation-active SMEs that have collaborated with a foreign partner

There are 71 innovation-active SMEs (60%) that have collaborated for innovation with a foreign partner. Almost all (111 out of 115) SMEs collaborated for innovation with a domestic partner (customer, end product user, competitor, research institute, university or supplier). Approximately 57% of the innovation-active SMEs in technical services (39 firms) and in mechanical engineering (15 firms) responded that they have collaborated for innovation with a foreign partner. In addition, 8 out of 11 (73%) biotech firms and 6 out of 10 (60%) consumer electronics companies responded that they have collaborated with a foreign partner. All respondent firms in the field of medical devices have collaborated with a foreign partner. (See Table 13.)

Table 13. The number of internationally collaborating innovative SMEs by sector and size class.

Sector	Size class						
	0-4	5-9	10-19	20-49	50-99	100-249	TOTAL
Biotechnology	4		1	2	1		8
Mechanical engineering	4	2	1	3	4	1	15
Consumer electronics	3	2	1				6
Medical devices	2				1		3
Technical services	34		4	1			39
TOTAL	47	4	7	6	6	1	71

The number of innovative firms that have no cross-border collaboration partners is 48. Three of them are biotech companies, 29 are technical service companies, 12 are mechanical engineering companies, and 4 are consumer electronics companies. The shares of only domestically collaborating innovative SMEs are the highest in mechanical engineering (44%) and in technical services (43%).

The position of innovation-active SMEs in the value chain

Approximately half of the innovation-active SMEs in the response group produce end products or are the main suppliers. One-third of them are subcontractors: equipment, service or components suppliers. Slightly more than 10% are contract manufacturers or systems suppliers. In an optional question about the companies' main positions in the value chain, 15% responded that they are consulting companies, research institutes, service providers, intellectual property service providers, technology providers, licensers, product developers, or another similar group.

Approximately the same proportions as in the whole sample of respondent SMEs can be found in the technical services sector, where half of the respondent SMEs are main suppliers and one-third are subcontractors. The corresponding figures for the mechanical engineering sector are 44 and 41 per cent, respectively. Approximately the same shares can also be found in the consumer electronics sector.

6.2 Innovation co-development

Customers are the main group of innovation co-developers for innovative SMEs. In total, 75 per cent of the respondent SMEs have co-developed and/or commercialised product, service or process innovations with customers in our survey. The same result is given in the other innovation activity-measuring surveys, such as CIS and SFINNO. End-product users and research institutes or universities are in second place, followed closely by equipment and service providers. Approximately 56 per cent of all SMEs have co-developed and/or commercialised innovations with end-product users and the same share with research institutes or universities.

Domestic customers are the most important innovation co-developers, especially for the mechanical engineering SMEs. More than 90 per cent of these companies stated that they have co-developed and/or commercialised innovations with domestic clients, which indicates that their innovation activities are largely demand based. For these firms, research institutes and universities appear as a second group, followed closely by domestic end-product users and suppliers. (See Figure 2.)

Approximately 40 per cent of innovative SMEs have co-developed product, service or process innovations together with their customers located outside of Finland (see Figure 3.). In this respect, the innovative SMEs in the mechanical engineering sector are quite similar to the SMEs in the technical services sector. However, the share of cross-border co-developers is a bit higher in mechanical engineering (44%) than in technical services (37%). In both of these sectors, foreign equipment or service suppliers are ranked second in co-developing innovations. Foreign research institutes and universities are rarely used as co-developers. The SMEs in technical services lean on foreign research institutes and universities to co-develop more often (15%) than the SMEs in mechanical engineering (7%).

In this study, co-developing is understood as continuous and strategic partnering with co-development partners. In contrast, the term collaboration does not necessarily include the co-creation aspect of the collaboration.

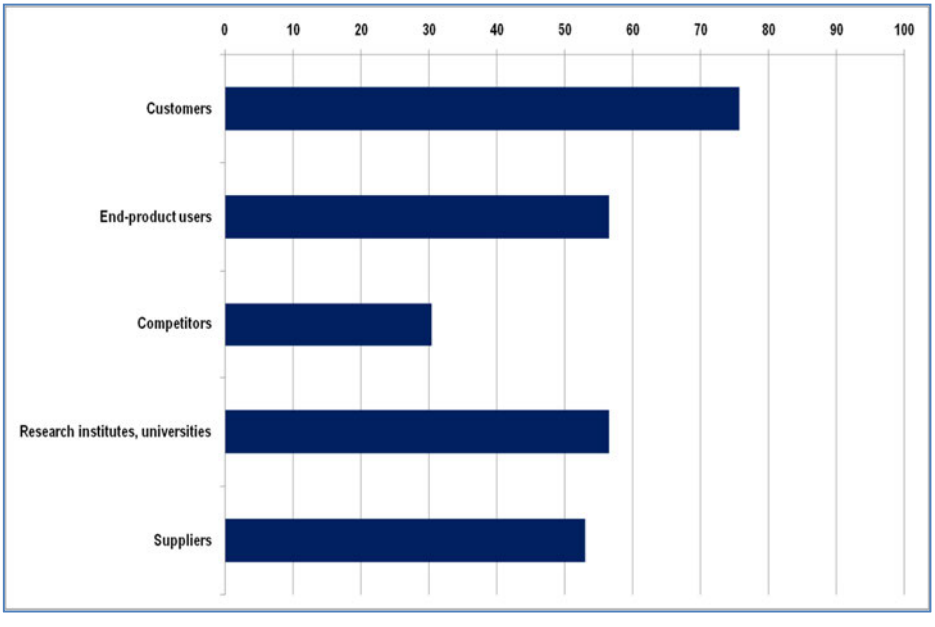


Figure 2. Domestic innovation co-developers; % of respondents (N = 115).

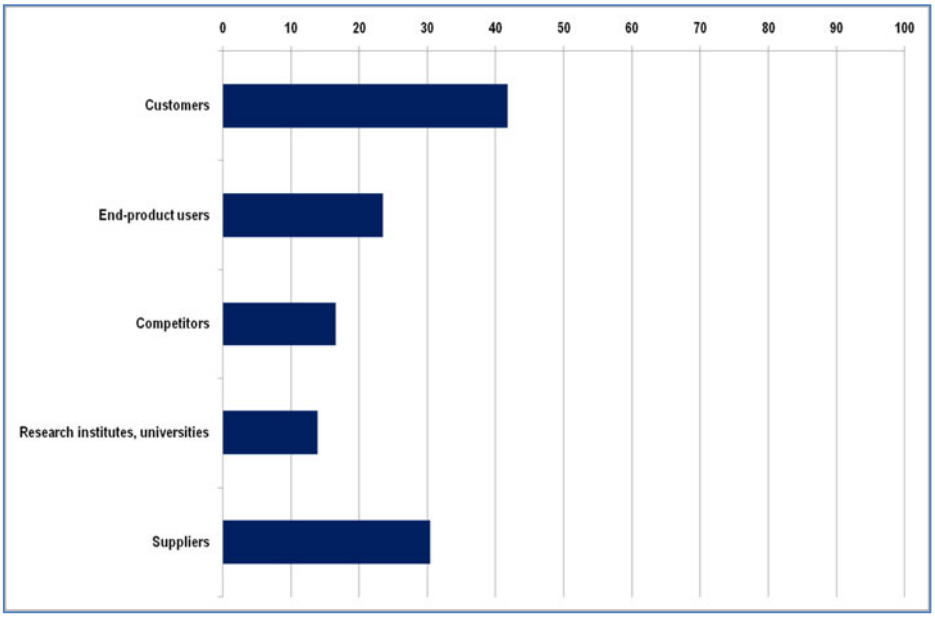


Figure 3. Foreign innovation co-developers; % of respondents (N = 115).

Ways to collaborate for innovation with customers

In technical services, collaboration for innovation with customers is prevailing, and more than 60% of SMEs stated that taking part in customers' development projects as experts describes well or quite well the ways in which they collaborate for innovation. The same share responded that executing projects fully determined by customers describes well or fairly well their collaboration activities. The SMEs in technical services (56%) also actively propose development processes to customers. In addition, a little less than half of the SMEs responded that taking part in the planning and preparation of their customers' development projects describes well or fairly well their collaborations with customers. This process describes well the innovation in service sectors, where innovating requires close cooperation or co-creation, as stressed in the service dominant logic literature (e.g., Edvardsson and Olsson 1996; Vargo and Lusch 2008).

Only 30% of the innovation-active SMEs in the mechanical engineering sector responded that taking part in customer's development projects as experts describes well their collaborations with customers, and the same share responded that participation in the planning and preparation of their customers' development projects describes well their collaboration activities. In this respect, the SMEs in mechanical engineering are much more likely to be standalone companies than service companies. (See Figure 4.)

A large proportion of firms' ideas for new innovations comes from customers and increasingly outside of national borders, as the following quotation from the case interviews clearly show.

"*We carry out a large part of research and product development here in Finland, but ideas come from abroad.*"

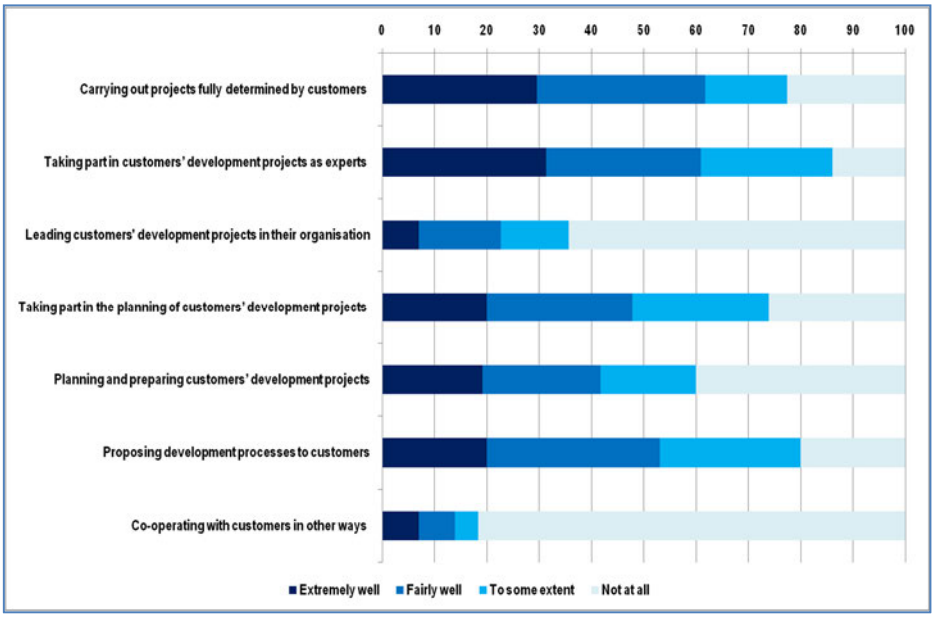


Figure 4. Type of customer collaboration; % of respondents (N = 115).

Ways to collaborate for innovation with competitors

The share of SMEs that collaborate for innovation with their competitors is low. Approximately 10 per cent of SMEs responded that pre-competitive collaborations, such as collaboration in standardisation, describe well or fairly well their collaboration activities with competitors. Approximately the same share collaborates in product and service development and in marketing. Collaboration with competitors in product and service development describes the SMEs in technical services better than the SMEs in mechanical engineering. The SMEs in mechanical engineering seldom collaborate in process development with their competitors. (See Figure 5.)

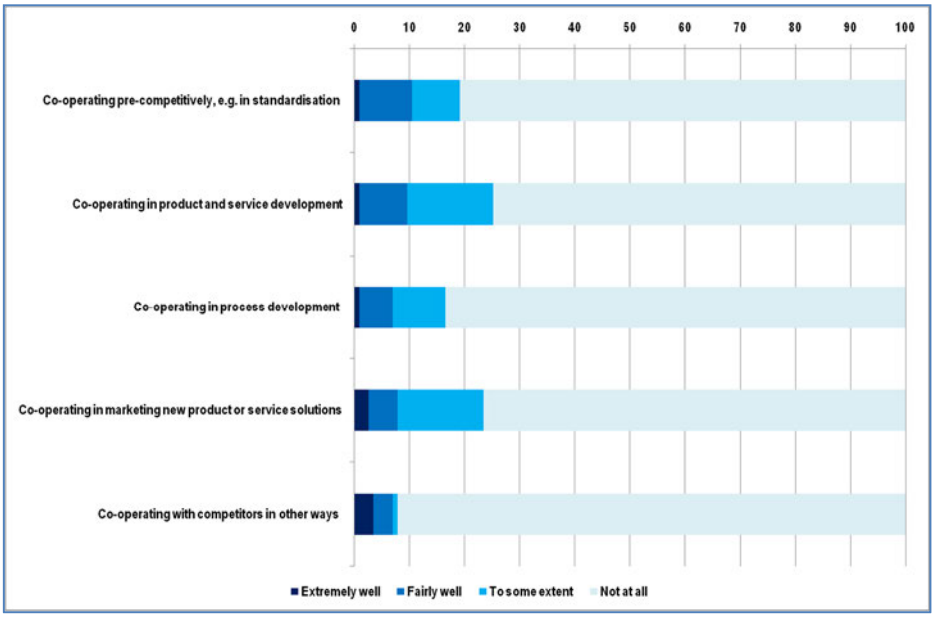


Figure 5. Type of competitor collaboration; % of respondents (N = 115).

Main areas for knowledge acquisition

Finland belongs to the main areas for knowledge acquisition for 95% of the respondent innovative SMEs. Approximately 70% of these SMEs mention that the Euro area belongs to their main knowledge sourcing areas. North America comes in third (44%), followed by other European countries (35%) and Asia (21%). Among the international SMEs in technical services, 54% of the companies responded that North America is their third most important knowledge sourcing area. Almost the same share (48%) can be found among the non-international technical service SMEs. The corresponding share among the international SMEs in mechanical engineering is 24%. These companies ranked North America together with Asia in fifth place, after Finland and Europe. The non-international SMEs in mechanical engineering have not given much importance to North America as their knowledge source.

The knowledge sourcing activities head mainly to Europe and North America, and the same patterns seem to apply to international and non-international SMEs. Asian countries seem to be more accessible to companies that have already gained experience in operating abroad. (See Figure 6.)

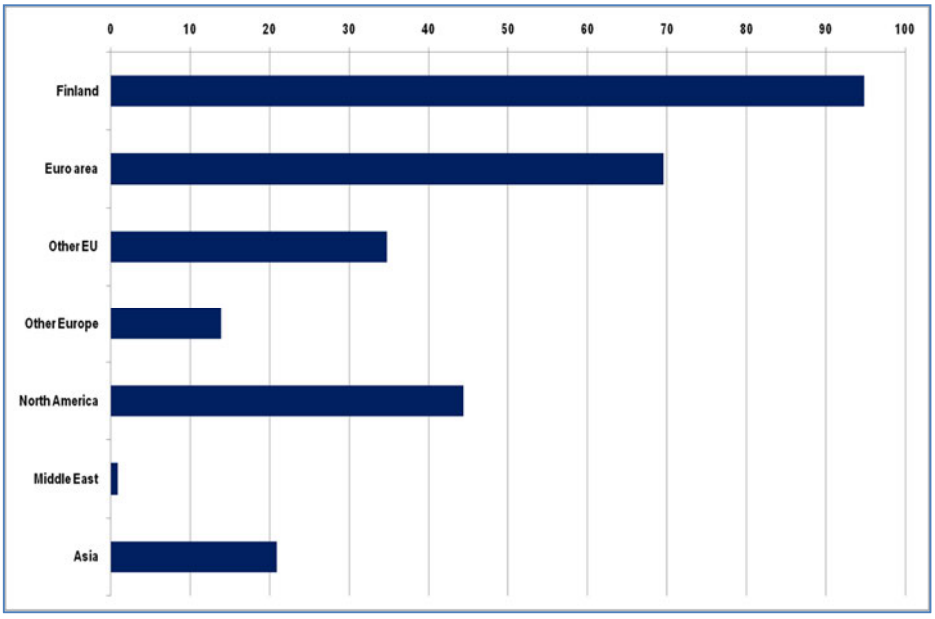


Figure 6. Main areas for knowledge acquisition; % of respondents (N = 115).

Openness to global knowledge flows

According to the innovative SMEs' responses, the openness of SMEs to international interfaces varies strongly with the sector and from company to company but is, as a whole, at the same level as in the CIS surveys in terms of co-developing activities. Approximately 40% of innovative SMEs have co-developed innovations together with their foreign partners. In total, 60% of the SMEs responded that they have collaborated for innovation with a foreign partner. The shares of cross-border collaborators are nearly the same (approximately 57%) in both the mechanical engineering and technical services sectors.

Ahvenharju et al. (2006) found that the science- and technology-based growth-oriented SMEs increasingly collaborate internationally but that the traditional forms of cooperation appear to be losing ground. SMEs seemed to enter non-equity types of agreements (such as alliances, joint projects, and outsourcing) rather than equity agreements (such as joint ventures). Although non-equity arrangements are the majority, almost 30% of the survey companies and 33% of the case companies had their own R&D units abroad (Ahvenharju et al. 2006).

However, we do not look at the "average firms" in the sectors in this study. One quarter (30 firms) of the respondent firms are high-growth firms, the same share as the proportion of innovative SMEs in the target sectors. These firms can be multinationals (21 firms) or at least become multinationals. Conversely, a purely

domestically operating firm can certainly be a high-growth firm, and there is no need for a firm to become multinational – at least in the short run.

When firms' absorption capacities measured by their R&D intensities are considered, we found 33 high-tech firms (24%) in the response group. Two-thirds of these companies are operating internationally. Therefore, it makes sense to take a glance at the companies' internationalisation processes or pathways, especially in terms of their knowledge and innovation activities, and to compare these processes with their characteristics. We will do so in chapter 7 after discussing the importance of external knowledge to SMEs.

7. Importance of external knowledge to SMEs

The aim of this chapter is to analyse different types of international knowledge and innovation activities and their relative importance to innovation and to SMEs to understand the combination of driving factors, motives, and barriers for international activities (or non-international activities) and their development, including the relation to MNEs.

7.1 The effect of international openness on innovation performance

Companies – and SMEs in particular – cannot maintain all of the knowledge required to deliver successful innovation onto the market. Innovation collaboration is a prominent means of accessing complementary knowledge. In a small open economy, international collaboration for innovation is paramount for accessing the required knowledge. International openness (i.e., openness to international knowledge flows) moderates/enables the effects of international knowledge externalities, which foster domestic innovativeness.

We identified a few studies that highlight this issue. For example, Laursen and Salter (2006) distinguished between breadth (range of external sources) and depth (importance of sources) in open innovation practices. They found that innovativeness is associated with the simultaneous use of different external information sources, that is, with broad or diverse search channels.

Conversely, Herstad et al. (2008) found that international linkages within the value chain are predominantly associated with superior innovation performance. With respect to internationalisation, studies have found that both multinationality in itself and the interaction between asset dispersion and host environment diversity impact performance positively (Frenz and Ietto-Gillies 2007; Goerzen and Beamish 2003). This finding indicates the superior search capacities of multinationals in different contexts (Herstad et al. 2010).

According to Nooteboom (1999b), an alliance is the general term for a number of inter-firm relationships that go beyond pure market transactions. For example, in alliances, parties share resources in R&D or product delivery such that they benefit mutually. The dimensions of alliances (or cooperation) can be categorised

as horizontal, vertical and diagonal. Diagonal alliances aim at 'market making' (i.e., developing new applications or product combinations with companies in third industries). The least sophisticated form of supplier relationship (i.e., vertical collaboration) is characterised by price competition and is used primarily to purchase standard components requiring basic production technology. Beyond routine operative contacts, there is no knowledge interchange between parties. At the other end of the continuum, there is the strategic partnership, in which supplier involvement is utilised to increase innovation, specialisation, quality, and price efficiency. Delegating planning and production responsibility to the supplier promotes effective technology solutions and allows the firm to focus on its core activities. Mutual commitment is supported by long-term contracts, in which price efficiency is pursued over an extended time period instead of in every transaction. Communication among partners is intensive and confidential and takes place at all organisational levels while affecting everything from operative to strategic issues (Ali-Yrkkö 2001). In contrast, horizontal collaboration takes place with competitors.

Results based on the Community Innovation Surveys

Based on the firm-level data on the information sources for innovation, the innovation protection methods, the outside-in innovation activities (e.g., new products and processes developed by others), external R&D and external machinery and licences, and collaboration for innovation (both domestic and international), a firm-level open innovation index (breadth: several partner types; depth: the importance of these partner types) can be compiled. Information sources can be divided into science and industry sources. The overall openness index can be calculated as a mean of breadth and depth.

Based on the CIS2004 and CIS2006, we investigated whether international collaboration impacts the innovativeness of Finnish firms in general and SMEs in particular and whether India and China play a focal role as collaboration partners in the innovation processes of firms. India and China are distinguished in the CIS2006.

We built up dummies for vertical (along the value chain), horizontal (with competitors) and science (with universities and research organisation) collaboration and for partners in the different geographic areas: European, US American, Chinese, Indian and other partners. As dependent variables, we used the following: (1) the introduction of new products to the market (dummy), (2) the top-performing companies (dummy for the above average share of turnover from new products in the industry), (3) the share of sales from new products (fraction), and (4) the share of sales from new products to the market (fraction). For dummy variables, we used probit models, and for continuous variables indicating fractions, we used fractional logit models (Papke and Wooldridge 1996).

We used the whole sample of 909 innovative companies over all sectors included in the CIS and found that collaboration within the value chain (vertical) and with competitors (horizontal) increases the companies' ability to bring new products to the market and the companies' economic returns to innovation (the share

of turnover from new products to the market). Comparable results were found for the reduced sample of 693 SMEs as well.

When using probit models for the likelihood of introducing new products to the market, we found the following results.

In the whole sample of innovative firms and SMEs in the CIS2004, the following is true:
- overall openness increases innovation (***),
- open innovation breadth increases innovation (***),
- outside-in activities and protection breadth increase innovation (***),
- internationalisation of the partner network increases innovation (*),
- science collaboration increases innovation (**),
- international horizontal collaboration increases innovation (**),
- vertical and horizontal collaboration with firms in the USA increases innovation (***).

In the whole sample of innovative firms in the CIS2006, the following is true:
- science (**) and vertical collaboration (*) increases innovation,
- international vertical (***) and horizontal (*) collaboration increases innovation.

In the sample of innovative SMEs in the CIS2006, the following is true:
- horizontal collaboration increases innovation (***),
- international horizontal collaboration increases innovation (***),
- horizontal collaboration with firms in India *decreases* innovation (**).

*** (**.*) indicate significance at the 1% (5%, 10%) level.

When using the fractional logit models for the share of turnover from new products to the market, we found the following results.

In the whole sample of innovative firms in the CIS2004, the following is true:
- overall openness has a positive effect (***),
- open innovation breadth has a positive effect (***),
- outside-in activities, collaborations and protection breadth have positive effects (***),
- internationalisation of the partner network has a positive effect (**),
- science collaboration has a positive effect (***),
- international horizontal collaboration with firms in the USA has a positive effect (***),
- horizontal collaboration with firms in Europe has a positive effect (*).

In the sample of innovative SMEs in the CIS2004, the following is true:
- overall openness has a positive effect (***),
- open innovation breadth has a positive effect (***),
- outside-in activities and collaboration breadth have positive effects (***),
- internationalisation of the partner network has a positive effect (**),
- science collaboration has a positive effect (***),
- international horizontal collaboration with firms in the USA has a positive effect (***),
- horizontal collaboration with firms in Europe has a positive effect (*).

In the whole sample of innovative firms in the CIS2006, the following is true:
- horizontal (***) and science (**) collaboration has a positive effect,
- international vertical (**) and horizontal (***) collaboration has a positive effect,
- vertical collaboration with firms in Europe and India has a positive effect (*),
- vertical collaboration with firms in China has a *negative* effect (*).

In the sample of innovative SMEs in the CIS2006, the following is true:
- horizontal (***) and science (**) collaboration has a positive effect,
- international vertical (**) and horizontal (**) collaboration has a positive effect,
- vertical collaboration with firms in Europe has a positive effect (*).

*** (**.*) indicate significance at the 1% (5%, 10%) level.

Global pipelines and local buzz

The notion of knowledge pipelines has traditionally been linked to the activities of multinational enterprises (UNCTAD 2005). Recently, it was extended to the studies of international search and collaboration more generally (Knell and Srholec 2008; Coe et al. 2008) and the large transfers of technology occurring as a result of being 'embedded' in components and machinery (Hauknes and Knell 2009). Global pipelines mean that companies can intentionally tap into international knowledge flows that are strategically organised and managed through their networks, subsidiaries and collaborations (see also Owen-Smith and Powell 2004; Bathelt et al. 2004).

Companies acquire knowledge and access to knowledge informally and (most of the time) unintentionally through local interactions and labour markets (local buzz). Assuming that multinational enterprises can work as a global pipeline for the national/regional innovation system, labour markets can transfer knowledge and access to knowledge to other firms, including non-internationalised firms. (See Figure 7.)

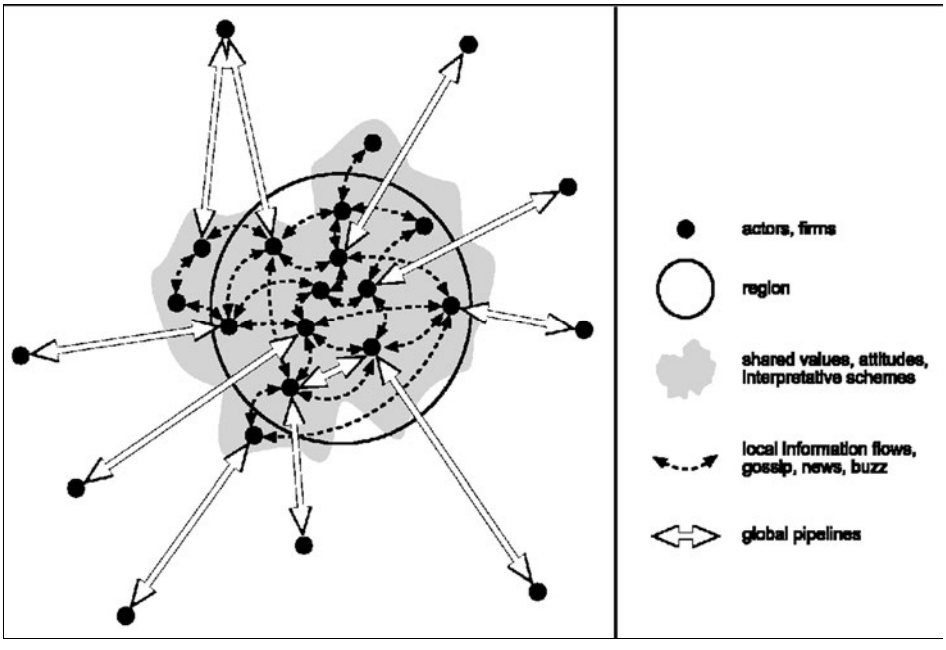


Figure 7. Local buzz and global pipelines (Bathelt et al. 2004).

We then investigate whether the inflow of employees who formerly worked for an MNE impacted the innovation capabilities of a firm in the Finnish innovation system. For this analysis, we linked the CIS2006 to the employer-employee data and the Business Register data. Here, the introduction of new products to the market is used as the dependent variable (dummy), and the flows of employees from the

multinational and national groups[33] to each company in the CIS are used as independent variables. The control variables include the firms' size (log of the number of employees), annual growth during the 10 years preceding the time covered by the innovation survey, export share, membership in a group, multinationality, R&D intensity, collaborations and sector. The annual inflows of employees are grouped by the level (basic, secondary, and tertiary) and field of education, discounted at a rate of 15%, and recorded from 1995 to 2004. As the inflow of employees can positively affect companies' attitudes towards innovation activities and companies' abilities to generate products new to the market, a selection equation has to be included in the regression. The selection variable is the execution of innovation activities. The model was estimated as a Heckman probit model.

We found that innovation capabilities increase with the overall (previous) inflow of employees from MNEs. Innovation capabilities positively affect the companies' overall attitudes towards innovation activities (selection equation) and the companies' capabilities to commercialise products new to the market (outcome equation). The inflow of employees from national groups does not have an effect.

When accounting for the degrees of education, we found that innovation capabilities increase with the (previous) inflow of employees who have tertiary education from MNEs. Once again, innovation capabilities positively affect the companies' overall attitudes towards innovation activities and the companies' capabilities to commercialise products new to the market. The inflow of employees with tertiary education from national groups does not have an effect.

Furthermore, when considering the fields of education, we found that innovation capabilities also increase with the (previous) inflow of employees who have technical education from MNEs. Additionally, they positively affect the companies' overall attitudes towards innovation activities and the companies' capabilities to commercialise products new to the market. The overall effects are also found in the subsamples of smaller companies (fewer than 1000 employees) and of companies from low or medium low technology sectors.

In summary, we found clear evidence of the following:

1) Collaboration for innovation and cross-border collaboration for innovation have highly significant positive impacts on the innovation performance of firms and thus their success (on average).
2) Knowledge flows from MNEs to other firms have a highly significant positive impact on the innovation performance of these firms (on average). The local buzz through labour markets is fed by the international activities and networks of MNEs and supports the innovation activities of other companies.

Although the significance of MNEs in the innovation environment is positive (e.g., in the form of providing a skilled workforce to SMEs), the perceptions of collaborat-

[33] National groups refer to the groups of companies that operate in Finland.

ing in innovation with large firms received quite reserved comments from the case firms. For example, the inability of small firms to defend their IPR in the co-development process was often mentioned.

> *"I avoid all this (cooperation with large research organisations and large firms) because of two issues: the business driver is not strong enough, and second, the problems in the IPR questions… an inexperienced small company will always be fooled."*

> *"Larger firms will access the knowledge themselves and are, of course, jealous of it. I understand that those who have resources are happy to get the knowledge and do not spill that knowledge over much to anywhere."*

In addition, the role of large multinationals' affiliates as an innovation knowledge channel was questioned and was seen as a challenge in the sectors where merger and acquisition activities had been rather active in the past several years.

> *"So these affiliates' ability to interact with this scientific community is really weak because the decision-making potential is not here but is out somewhere else. So these affiliates are mainly profit-making machines."*

7.2 Types and sources of knowledge for innovation

In this section, we consider whether there are differences in the significance of various types and sources of knowledge for innovation among sectors, between international and non-international SMEs and between high-growth and non-high-growth SMEs. We compare the mechanical engineering and technical services sectors. These observations are based on the survey responses. In both of these groups, the shares of cross-border collaborators among the innovative SMEs are nearly the same (approximately 57%). However, in the response group, the share of international companies is higher in the mechanical engineering sector (78%) than in the technical services sector (55%).

Knowledge types

The most frequently sourced types of domestic knowledge acquired by SMEs are in the following order:

1) wishes, ideas and design,
2) technological and scientific knowledge (including testing and standards),
3) knowledge on markets and business environments,
4) knowledge on business models and ways of action.

The most frequently sourced types of overseas knowledge acquired by SMEs are as follows:

1) technological and scientific knowledge,
2) wishes, ideas and design,
3) knowledge on markets and business environments,
4) knowledge on business models and ways of action (see Appendix 5).

Importance of knowledge sources

The firm or its corporate group is seen as the most important domestic knowledge source for innovation in SMEs, followed by the customers, the main suppliers, and the suppliers of equipment, materials, components or software. Almost 90% of the innovative SMEs give a high or medium importance to the firm or its group as their knowledge source. The second most important group (77%) consist of domestic customers, and the third group (60%) consists of domestic suppliers. The fourth place (47%) is given to public actors, such as ELY centres, Finpro and Tekes. Universities and polytechnics (44%) are the fifth most important knowledge source for innovative SMEs. Public or private non-profit research organisations are far behind: 25 per cent of the innovative SMEs consider them to be important knowledge sources (Figure 8).

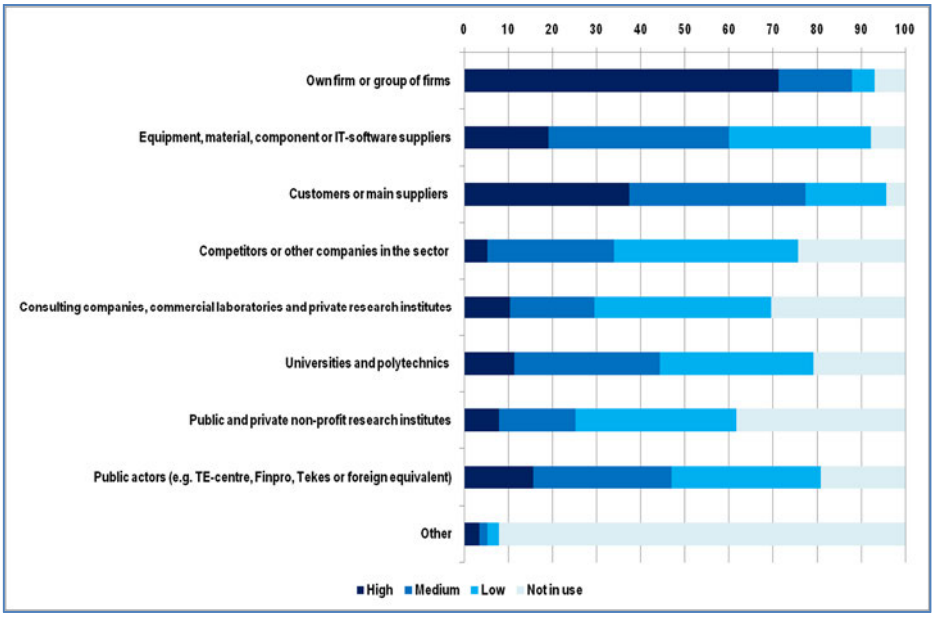


Figure 8. Importance of domestic knowledge sources in innovation activity; % of respondents (N = 115).

The most important foreign actors are customers and suppliers. Companies monitor competitors or other companies in the sector when searching for knowledge on business models and ways of action. Foreign universities and polytechnics are monitored when searching for technological and scientific knowledge. Approximately 40% of innovative SMEs give a high or medium importance to foreign customers and suppliers as their foreign knowledge sources. The third most important (25%) group consists of foreign competitors or other firms in the sector. The firm

or its corporate group abroad is seen as the fourth most important group (20%). The fifth most important type of foreign organisation consists of universities and polytechnics (13%), followed by public or private non-profit research organisations (9%) and public actors (8%) (Figure 9).

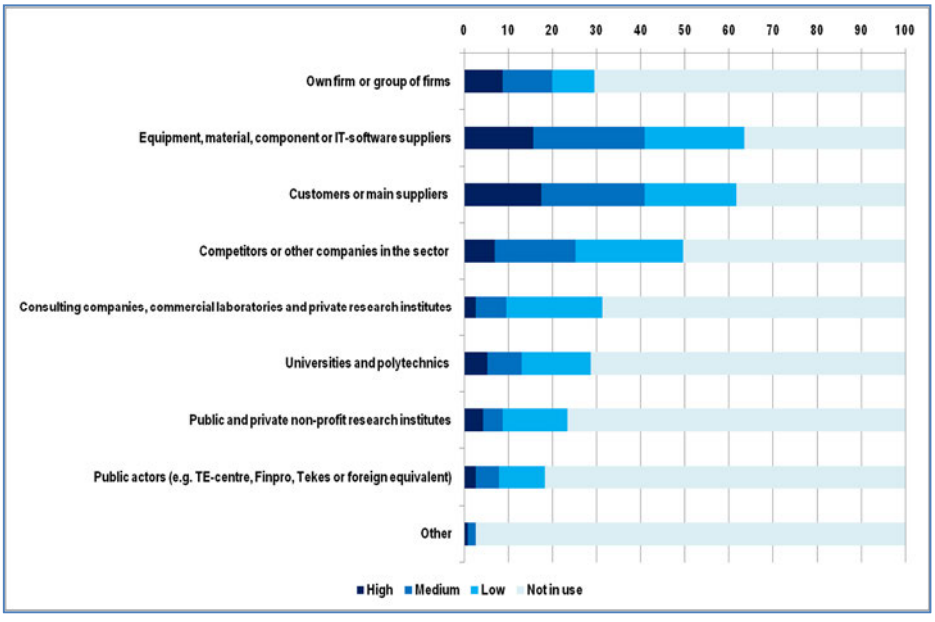


Figure 9. Importance of foreign knowledge sources in innovation activity; % of respondents (N = 115).

There are no significant differences between the international (37 firms) and non-international (31 firms) SMEs in the technical services sector in terms of the importance they give to different types of domestic organisations. However, non-international SMEs consider competitors to be more important (41%) than international SMEs do (21%). They also give a higher importance to public or private non-profit research institutes (29%) than the international SMEs in technical services do (18%).

Approximately 58 per cent of the international SMEs in technical services give a high or medium importance to foreign customers as their knowledge source, and approximately 35 per cent give a high or medium importance to foreign suppliers. Competitors or other firms in the industry are the third most important type of foreign organisation (30%). Understandably, the non-international SMEs in technical services do not give as high importance to foreign customers as the international SMEs do. The same holds true for the importance of other foreign actors.

The most important type of overseas knowledge acquired by the international SMEs in technical services is knowledge on their competitors' business models

and ways of action. The second most important type is the wishes, ideas and knowledge on markets and business environments held by their customers. For the international SMEs in mechanical engineering, the market type of knowledge is clearly the most important one, followed by the knowledge on customers' wishes and ideas and on customers' business models and ways of action. Monitoring customers' business models versus competitors' business models reflects the distinctions between service firms and manufacturing firms, respectively. Service firms are more likely to be standalone firms than small manufacturers.

When comparing the knowledge acquired domestically by the high-growth SMEs (15 firms) and non-high-growth SMEs (54 firms) in the technical services sector, we find that the non-high-growth companies source knowledge more often from their own group of firms (56% vs. 52%), from suppliers (25% vs. 20%) and from consulting companies, commercial laboratories or private research organisations (23% vs. 13%) than the high-growth SMEs do. However, there are no significant differences with respect to the other domestic knowledge sources.

When the foreign sources for technical service companies are considered, the non-high-growth companies source knowledge more often from their own group of firms (19% vs. 13%) and from their suppliers (17% vs. 13%) than the high-growth companies do. Conversely, competitors outside of Finland seem to be more important knowledge sources for the high-growth companies than for the non-high-growth companies (18% vs. 14%). There are no significant differences with respect to the other foreign knowledge sources.

In mechanical engineering, approximately 42% of the international SMEs highly appreciate foreign customers as their knowledge source for innovation. Almost 30% give a high or medium importance to suppliers and approximately 25% to their own group of firms abroad. Foreign competitors are not given such importance by the mechanical engineering companies as are given by the international service companies.

- The firm or its corporate group is seen as the most important domestic knowledge source (90%), followed by customers (77%), suppliers (60%), public actors (47%), universities and polytechnics (44%).
- Foreign customers and suppliers are the most important foreign knowledge sources (40%), followed by competitors (25%), the firm or its group abroad (20%) and universities and polytechnics abroad (13%).
- In-house R&D is the most important way to acquire knowledge, and foreign affiliates, suppliers and partners are seen as the most important ways to generate cross-border knowledge.

Motives for using foreign knowledge

Creating new products, services and/or new businesses and staying at the forefront of research and development are the most important motives for using foreign knowledge sources among the innovation-active SMEs (see Figure 10.).

These motives are followed by the non-availability of domestic knowledge and access to new markets or cognisance of the customers' needs. Acquiring technology and/or special know-how is also of high importance to SMEs. In contrast, moving R&D closer to customers and/or production receives the lowest importance.

The same motives are highly rated by the non-international SMEs in technical services. The non-international SMEs in consumer electronics view the non-availability of domestic knowledge clearly as their most important motive for sourcing foreign knowledge. Staying in the forefront is rated as the second most important. Conversely, the non-international SMEs in mechanical engineering do not consider the non-availability of domestic knowledge to be as important as the technical service and consumer electronics firms do.

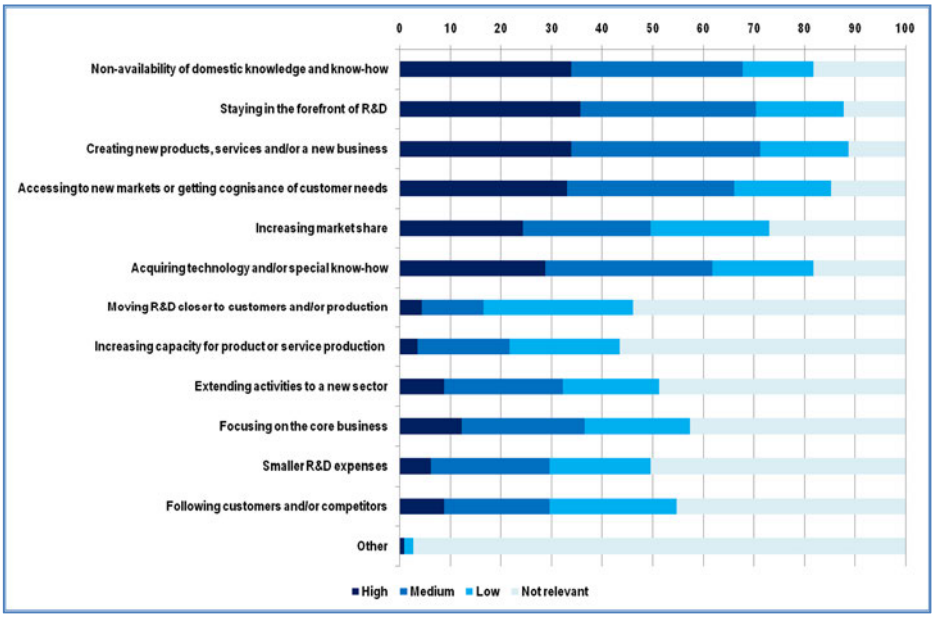


Figure 10. Importance of motives for using foreign knowledge for innovation; % of respondents (N = 115).

International service companies give the highest importance to the creation of new products, services and/or new businesses, while international manufacturing companies give the highest importance to access to new markets or cognisance of customer needs, as do the international SMEs in consumer electronics (see Table 14). Consumer electronics international SMEs also highlight the increase in their market share as an important motive for using foreign knowledge sources.

Table 14. Importance of motives for using foreign knowledge for innovation among the internationally operating respondents in technical services and mechanical engineering.

Motive	Technical services (N = 37)	Mechanical engineering (N = 21)
1.	Creating new products, services and/or new businesses	Access to new markets or cognisance of customer needs
2.	Non-availability of domestic knowledge and know-how	Creating new products, services and/or new business
3.	Access to new markets or cognisance of customer needs	Staying in the forefront of R&D
4.	Staying in the forefront of R&D	Increase in market share
5.	Acquiring technology and/or special know-how	Acquiring technology and/or special know-how

Staying in the forefront of research and maintaining tight relations with basic research are important, especially in the high-technology sector, as the following comments indicate. However, for a young start-up, scarce resources hinder the parallel development of technologies or applications for the technologies. The idea selection process is the most challenging phase for many firms.

> "*I have one extremely interesting technology waiting. It is in the university incubator, and we are waiting for the right moment to include it in our technology portfolio. However, the aim is to develop it ourselves. We have a clear concept… first, we need to get gears. Then, we can buy and internalise. This is one of the common problems; Finnish firms acquire and import many technologies, but they don't have either money or time for anything. You need to focus.*"

> *"From a SME perspective, we do not have muscle, no power not so ever. We barely can develop the existing core, but the applications are super important. Every time I meet someone who gives me an idea for a new application, I say, 'Mm, yes nice idea, would you do that, you are welcome'."*

8. Different modes of knowledge sourcing among SMEs

The aim of this chapter is to examine the cross-border knowledge sourcing mechanisms in SMEs operating in different sectors. We also plan to investigate how the sourcing patterns differ among SMEs already operating in international markets and among those that have only domestic operations. These mechanisms are called various names: modes or channels of knowledge sourcing, open innovation modes in the context of global networks (OECD 2008), or knowledge transfer mechanisms. They are further divided into direct mechanisms, which are understood to be contract-based cooperative interactions, and indirect non-contractual mechanisms, such as participation in social networks, seminars and trade fairs.

8.1 Different modes of knowledge sourcing

The understanding of international K&I activities and transfer applied in this research relies partly on the thinking of Archibugi and Michie (1997). Companies, particularly MNEs, are clearly more involved in international cooperative arrangements. They source proprietary technology and know-how abroad both through their own R&D facilities and through contractual agreements (contract R&D, joint R&D agreements and corporate high-technology ventures). They also increasingly set up more collaborative relations with suppliers, customers, universities, and other actors as part of their innovation strategies (OECD 2008). Moreover, this phenomenon occurs among not only MNEs but also SMEs, especially technology-intensive SMEs that are able to participate in global innovation networks.

A contract provides a right of entry to other firms' knowledge resources, which provide diversity and novelty, as required by innovation (Nelson and Winter 1982; Nooteboom 1999a). A crucial function of the firm, as seen, for example, by the Uppsala school (see, e.g., Forsgren et al. 1995; Aoki et al. 1990), is to manage the set of contracts (i.e., network relations). This function includes building, establishing and maintaining favourable network relations and coordinating activities related to partner firms (Paasche et al. 1993). To diminish the transaction costs incurred by contract formulation, firms are increasingly looking for non-contractual ways to

enforce mutually beneficial relationships. Accordingly, short-term contracts are replaced with long-term agreements to build trust and reciprocity (Ali-Yrkkö 2001).

In accessing and sourcing external technologies and knowledge (i.e., the outside-in process of open innovation), EIRMA (2004) distinguished the following modes:

1) purchase of technology,
2) joint venturing,
3) alliances,
4) joint development,
5) contract R&D,
6) licensing,
7) collaborations with universities,
8) equity in university spin-offs,
9) equity in venture capital investment funds.

The innovation development process is often an interactive process that requires companies to engage in collaboration and form various types of collaborative arrangements to ensure sufficient knowledge transfer (Howells et al. 2003). The knowledge can be acquired on a contractual basis from R&D alliances, partnerships or collaborative agreements (Hagedoorn 1993). Moreover, inward technology licensing and purchasing are valuable means of strengthening innovation activities. Many of the collaborative forms aim to strengthen the technological expertise of a company's research and therefore are important forms of collaboration, particularly to science-based companies.

In addition to the less equity demanding forms of innovation collaboration described above, in some cases, the joint research is conducted in more involving and intensive modes, such as joint research ventures (Hagedoorn et al. 2000). These types of partnerships are especially suited for innovation co-development. However, innovation collaboration is not concentrated only on innovation development. Rather, alliances in marketing, distribution, and manufacturing are also formed to complement a firm's own capabilities, for example, in the commercialisation phase (Forrest 1990). In addition to formal types of innovation collaboration, some more informal, or passive, activities tightly tied to innovation development can also be recognised. Based on the division by Dahlander and Gann (2010), these activities would include inbound sourcing (i.e., non-financial) practices. These practices include, for instance, scientific/technical conferences, in-house seminars hosted by leading international speakers or a company's technical advisory panel led by outside experts (Ronstadt and Kramer 1983). Moreover, the external participation in the form of equity investment into (or out of) a company is a good example of knowledge transfer in which investors themselves act as a knowledge pipeline, as they take part in the management board (van de Vrande et al. 2009).

However, for companies to utilise externally sourced knowledge in-house, their internal capabilities are required to convert it into a usable form – this capability is called absorptive capacity (Cohen and Levinthal 1990; Zahra and George 2002). It constitutes the abilities to value, integrate and combine various types of

knowledge inputs. Although absorptive capacity is modelled in various ways, the general understanding is that it is a set of abilities that manage knowledge and enable the firm to attain positive results (Zahra and George 2002).

There is a set of practices (Figure 11) through which firms may search, source and collaborate to different degrees, depending on the sectorial contexts in which they operate and the institutional contexts in which they are located (see Herstad et al. 2010).

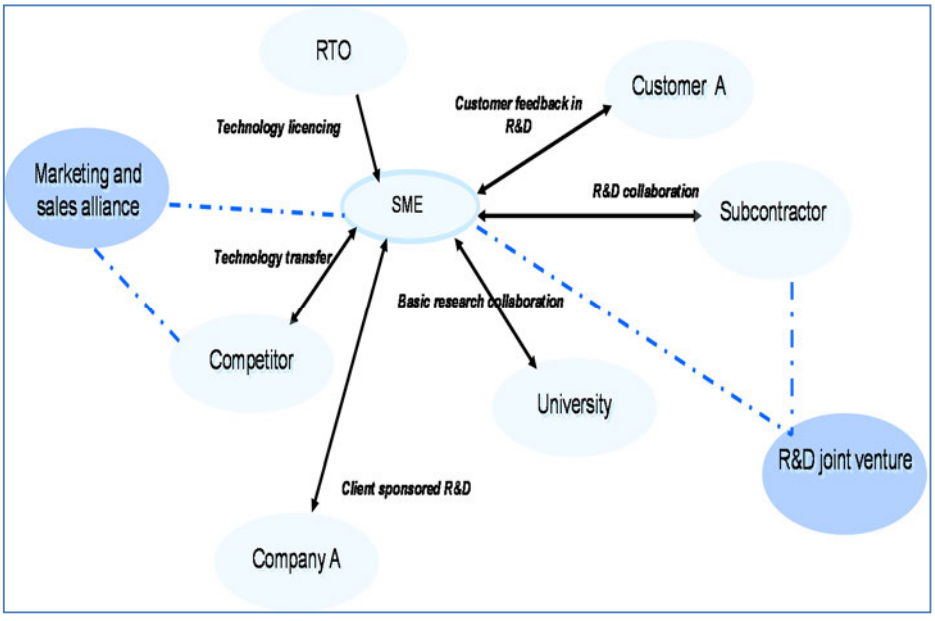


Figure 11. Different knowledge sourcing channels of a SME (source: own compilation).

The drivers of cross-border collaboration in R&D include the following: similarity of technologies across countries, which increases the competitive pressure for enterprises; development of clusters, which makes technologies specific to a particular location; cross-fertilisation of technology among sectors; and the costs and risks associated with innovation. However, at the individual company's level, engagement in international R&D activities is based on strategic decisions (i.e., the ways the companies choose to react to the external conditions). In many cases, international R&D collaboration has become the first-best option for firms aiming to reach their objectives and manage the push factors or take advantage of the pull factors. However, there are also other ways of managing these issues, and a company-level analysis of international R&D activities has to start by understanding a company's strategy (Ahvenharju et al. 2006).

8.2 Cross-border knowledge sourcing in SMEs

If we look at the importance of knowledge sources in innovation activity, we see that the SMEs that rank customers, competitors, consultants and public intermediary organisations highly do so equally often for domestic and foreign actors. If foreign competitors are ranked highly, then so are all of the other foreign sources. This correlation does not hold for domestic knowledge sources. According to the correlations, there are two clear groups of innovative SMEs: research-intensive SMEs and other types of SMEs. The R&D-intensive small businesses develop novel innovations and operate on a global scale since their foundation; therefore, global access and absorption of K&I are prerequisites for their growth and progress.

Conversely, the SMEs that rank domestic acquisition of equipment, materials, components or software as important also highlight the importance of training. If foreign channels are concerned, strategic partnerships, public services, project-based knowledge exchanges and purchase of market surveys and technological information are also seen as important. The SMEs that highlight the purchase of knowledge, patents and licenses value strategic partnerships to a lesser degree. Accordingly, there are two basic strategies for knowledge sourcing: the co-development (collaborative innovation) and the purchasing-based strategies. The latter, short-term knowledge sourcing strategies are used primarily when sourcing knowledge from abroad.

Taking part in collaboration networks is seen as important in both Finland and abroad. When entering a foreign collaboration network, an SME typically also enters foreign conferences, trade fairs and research programmes. It seems to be more important for innovative SMEs to take part in foreign research programmes than in domestic ones.

For the SMEs that rank the non-availability of domestic knowledge as an important motive for using foreign knowledge for innovation, technology transfer is important. Acquiring technology and/or special know-how is also important for the companies that highlight the importance of staying at the forefront of R&D. This motive correlates highly with the creation of new products, services and/or new businesses, as well as with access to new markets or customer needs.

The correlation with the reduction of R&D expenses is much lower. The SMEs that want to come closer to their customers also give a high importance to increasing their market share, and the SMEs that want to reduce their R&D expenses typically also want to focus on their core business. Capacity sourcing does not correlate with the motive of global innovativeness, which is measured as a wish to stay at the forefront of R&D or to create new products and services in the international markets.

Importance of direct channels in knowledge sourcing

A broad variety of ways to search, collaborate and source knowledge for innovation are used when domestic sources are under consideration (see Figure 12.). In-house R&D is by far the most important way to acquire knowledge. Strategic, long-

term partnerships with other domestic companies are seen as the second most important way by half of the companies, and domestic suppliers are seen as the third most important one. These channels are followed by contract R&D, training (own or purchased externally), public services (e.g., ELY centres), project-based cooperation and knowledge exchange, and purchasing of other knowledge (e.g., market surveys and technological knowledge). Recruitment of R&D personnel is seen as an important channel for obtaining access to external knowledge by 18% of companies and for purchasing patents and licenses by 13%. Joint ventures, equity investments in other companies and acquisition of R&D units or companies are not seen as important channels, which is understandable in the SME context.

In the technical services sector, more than half of the international SMEs give a high or moderate importance to strategic partnerships with domestic companies. Almost 55% of the non-international SMEs value suppliers highly as their knowledge sources, and approximately 45% regard domestic partners as important. Not surprisingly, domestic knowledge sources are of more importance to the non-internationally operating SMEs than to the international SMEs.

In the mechanical engineering sector, the international SMEs give a high or medium importance to in-house R&D, domestic suppliers, partners and contractors, but they do not regard long-term partnership as important as the SMEs in the technical services sector do.

Foreign suppliers and affiliates are the most important cross-border knowledge sources for the SMEs under consideration (see Figure 13.). Foreign strategic partnerships are also seen as important, followed by the acquisition of market reports and technological knowledge and project-based development and knowledge sharing.

In technical services, a strategic, long-term partnership with a foreign partner is perceived as the most important method of obtaining access to cross-border knowledge among the SMEs operating internationally. The other important channels consist of suppliers and in-house R&D. Among the SMEs operating domestically, supplier relations are valued higher as a source of innovation information than in-house R&D activity.

In contrast, in the mechanical engineering sector, sourcing market reports and technological knowledge from abroad comes as the first means of accessing knowledge, followed by foreign affiliates' R&D, strategic partnerships and supplier relations. The non-international SMEs regard only foreign affiliates and suppliers as important knowledge sources but have not established any longer-term relations with foreign partners to source knowledge.

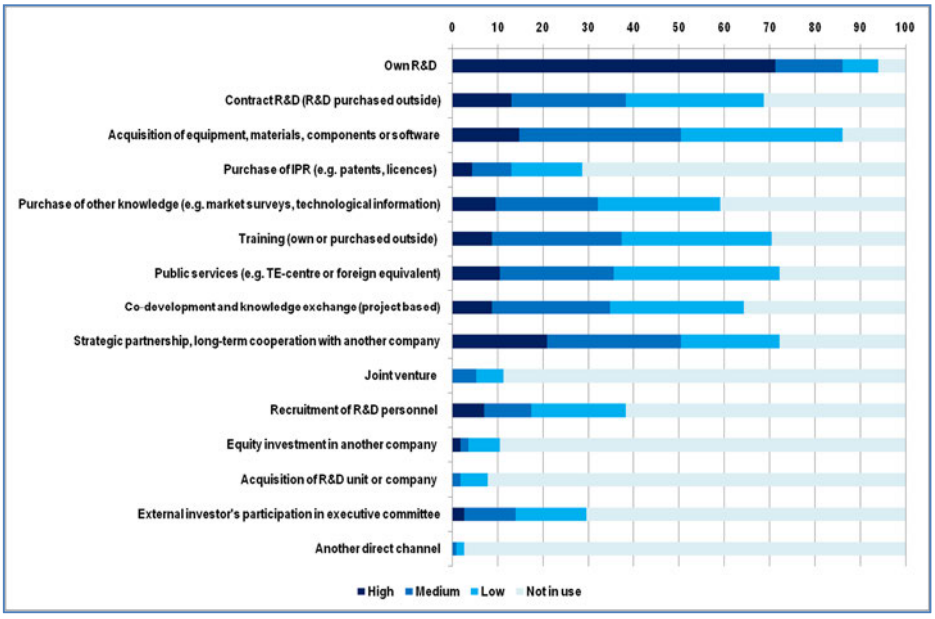


Figure 12. Importance of direct domestic channels in knowledge sourcing; % of respondents (N = 115).

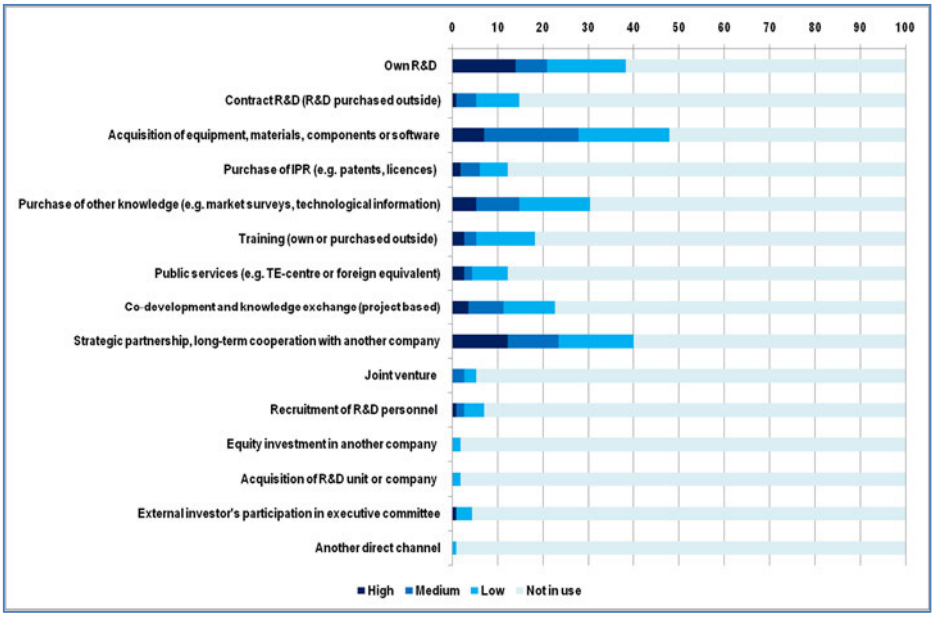


Figure 13. Importance of direct foreign channels in knowledge sourcing; % of respondents (N = 115).

The perceptions of collaboration vary. A less-open collaboration culture in the industry might hinder the good intentions of co-development, as shown by the following comments.

> *"Many firms have a confidentiality (article) in their employment contract, a conditional imposition of a fine and so on… but is this expedient? We plug with this. Cooperation starts from the point where people interact… we should have a more open culture. The firms' researchers share ideas in a direct and reciprocal manner."*

Often, the firms also feel that knowledge is not transferred concretely but that innovation collaboration is conducted for the sake of collaborating, especially in the larger, publicly supported technology projects.

> *"We go after knowledge. That's certain… We can have ideas on the generic level, but to gain knowledge on the concrete cooperative level, not really."*

> *"… it (the cooperation with competitors in a technology programme) was this kind of knowledge-sharing process; no products are discussed because then all communication will be terminated at once."*

Importance of indirect channels in knowledge sourcing

We also wanted to explore informal means of accessing knowledge, as not all crucial innovation knowledge is available via formal channels. When indirect channels based on social networks, public sources, communities and conferences for knowledge acquisition are considered, the social networks inside Finland are the most important channels to a little more than 50% of SMEs, followed by domestic conferences, fairs and exhibitions (40%) and participation in, for example, Tekes's technology programmes (35%) (see Figure 14.).

In the technical services sector, the international SMEs give high or medium importance to the abovementioned domestic channels. The non-international SMEs also highlight the importance of scientific and trade journals. In the mechanical engineering sector, conferences, fairs and exhibitions are considered the most important channel, followed by social networks and technology programmes. The non-international SMEs give high importance only to collaborative networks and conferences, fairs and exhibitions.

Regarding cross-border knowledge sources, conferences, fairs and exhibitions are ranked first, tightly followed by scientific and trade journals (see Figure 15.). Almost 30 per cent of SMEs regard participation in cross-border collaborative networks as important.

In the technical services sector, the international SMEs highlight the importance of scientific and trade journals, conferences, fairs and exhibitions and cooperative networks. The non-international SMEs give relatively more importance to scientific and trade journals than the internationally operating SMEs. In the mechanical engineering sector, the international SMEs give high importance only to confer-

ences, fairs and exhibitions, whereas these channels are only of medium importance to the non-international SMEs.

It is evident that the companies operating in an international environment exploit cross-border channels more often than the firms that only operate domestically do. However, the distinction is less obvious if the use of indirect knowledge transfer mechanisms is considered instead of formal mechanisms. It is apparent that the use of cross-border sources increases as companies gain international experience. International and non-international companies behave quite similarly in terms of their main geographical areas in knowledge acquisition.

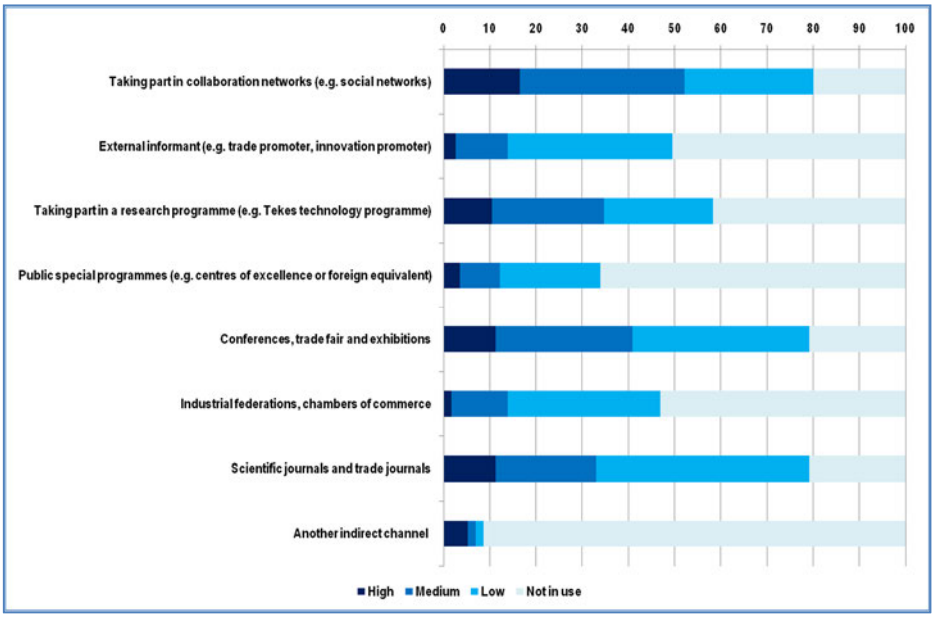


Figure 14. Importance of indirect domestic channels in knowledge sourcing; % of respondents (N = 115).

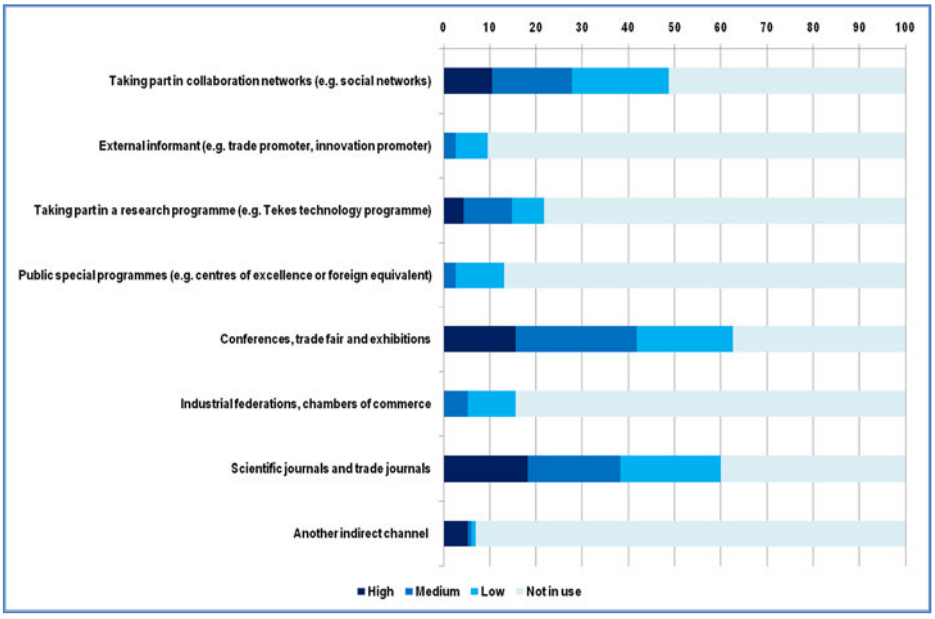


Figure 15. Importance of indirect foreign channels in knowledge sourcing; % of respondents (N = 115).

Barriers to using foreign knowledge

The difficulty of finding a competent partner is the primary barrier to the use of foreign knowledge sources (see Figure 16.). Concerns over leaking core competencies to a supplier or partner comes as the second greatest hindrance, followed by concerns over spreading R&D or technologies important to a firm's competitive advantage.

These same worries can be observed among both the service firms and the manufacturing firms. The manufacturing firms also highlight language and cultural barriers, which are not seen as highly significant among the technical service firms. Among the internationally operating service firms, the challenges to engaging in further cross-border knowledge sourcing relates to the ability to absorb tacit knowledge and to identify partners. The latter is also relevant to the non-international group. Leaking core competencies to external partners is also a common worry.

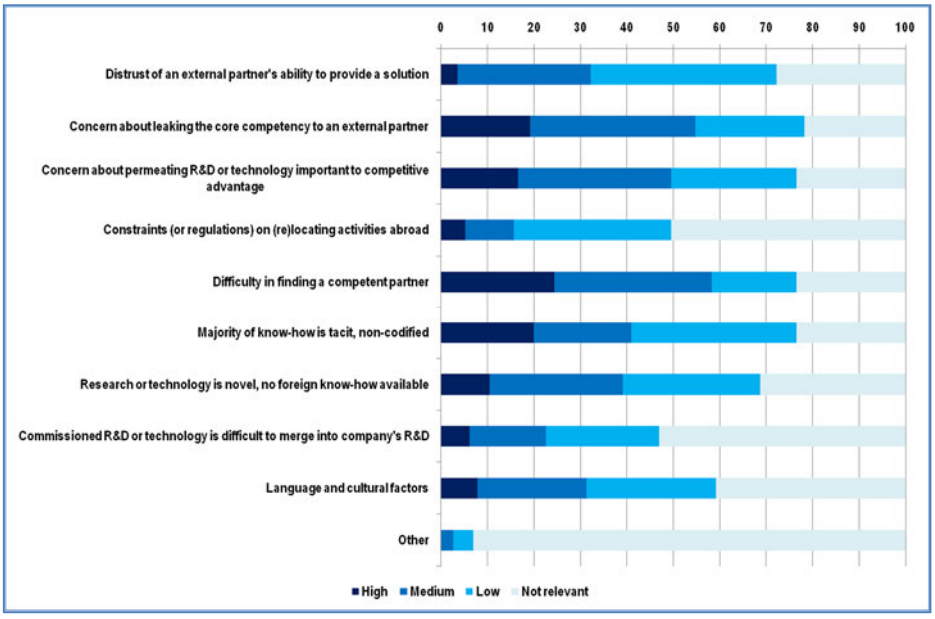


Figure 16. Importance of barriers to using foreign knowledge for innovation; % of respondents (N = 115).

Although the motives for collaborating are evident in many small businesses, might the realities of collaboration differ, as the following comments of the case company representatives indicate?

> *"We would have so much to do in the area of basic research because this is a new technology and many new things are introduced. But the business driver is too far from it (the basic research). Right now, we need to do business."*
>
> *"We only cooperate with those, who are so enthusiastic that they themselves actively approach us…(as we do not have the resources for co-operation)."*
>
> *"If you progress (innovate) in a tight business environment, where already exist production, sales, fuzz and so on already exist, there isn't really any time to innovate anyone."*
>
> *"Micro firms do not have the resources to actively establish (cooperation relations) and recruit persons. It is very difficult. …but a 250 employee firm probably already has the resources for that. There are one or a few guys, who can 'hop in and out' of international research. …"*

The resource restrictions for concrete collaborations seem to be prevalent in small businesses and to extend beyond reaching the knowledge. The firms know where the important K&I knowledge lies, but often the smallness of the firm (i.e., resource (personnel or financial) restrictions) were mentioned as the main barrier to utilising

the knowledge currently. However, the usefulness of excessively direct access to knowledge was also doubted in one interview:

> *"Of course, when a firm is in the early stages, it deserves to get support. But after a while you need to understand, where your competitors move, where you want to go and where it is worth going. ….you need to get this information (about different market areas) and develop information further yourself."*

Overall, the capability to absorb the acquired knowledge is an important aspect of a firm's innovation activity, as innovation collaboration or sourcing per se is not enough.

Absorptive capacity and foreign knowledge sourcing

Although different dimensions of absorptive capacity are acknowledged in the literature (Zahra and George 2002), a solid understanding is missing. Absorptive capacity is believed to comprise different activities for sourcing and utilising external knowledge to improve a firm's innovation activity. One often used measure is the different R&D indicators of the firm. In this study, the absorptive capacity of a firm is defined as the logarithm of its median R&D expenditure from 1997 to 2007 and as the corresponding R&D intensity. The median over these years is used because the annual R&D expenditures for each survey firm are not known. R&D intensity is defined as a share of median R&D in turnover in the year 2007.

The correlation tables (see Appendix 6) show that the higher the absorptive capacity of an innovative SME, the more often it will collaborate for innovation with its foreign customers, end users, research institutes and universities (public research organisations, PROs). There is no significant correlation between the absorptive capacity and the domestic collaboration. The SMEs that collaborate for innovation with their foreign customers also do it quite often with foreign PROs. Furthermore, the SMEs that collaborate with foreign end-product users also often collaborate with foreign PROs and competitors or other companies in the sector.

A firm's absorptive capacity correlates strongly with its foreign direct knowledge sourcing but not with its domestic knowledge sourcing and less with its foreign indirect knowledge sourcing. The higher the research intensity of an SME, the more often it is engaged in direct knowledge sourcing with foreign customers, suppliers and PROs. High research intensity also correlates strongly with the participation of an external investor in the firm's executive committee, with the purchase of foreign market surveys and technological information, with engagement in foreign strategic partnerships, and with the recruitment of foreign R&D personnel.

Research-intensive SMEs primarily access foreign knowledge sources to create new products and services, access new markets and understand customer needs. Research intensity also correlates strongly with the barrier of excessive novelty (i.e., the research or technology is so novel that foreign know-how is not available).

The most important internationalisation objectives of the research-intensive SMEs are in the following order: outsourcing production or part of it to external companies abroad, launching cooperation with a foreign company, outsourcing R&D or part of it to the SME's own subsidiaries abroad, establishing a joint ven-

ture together with a foreign company, establishing a strategic alliance with a foreign company, establishing or acquiring a foreign unit, and outsourcing R&D or part of it to external companies abroad.

Although it is evident that firms with higher R&D intensities have better absorptive capacities, many small innovative firms seriously suffer from resource restrictions in this respect. Often, one person takes care of many crucial activities in the firm, as can be learned from the following answers regarding corporate R&D resources:

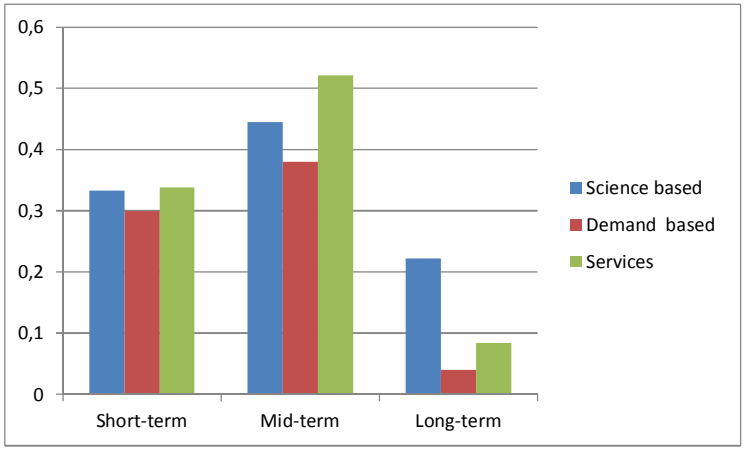
> *"We have in reality two blokes, N.N. who officially holds the title of CEO, and then we have another bloke whose title is sales manager, but they are now our main R&D team and the production manager in practical issues."*

> "*It is true that we don't have a CTO. We had one, but the relationship ended in 2007, I think. After that, we haven't had basic research; we have only had applied (research)…"*

> "*We have one person who coordinates the R&D, and I take care of the worldwide sales and the whole distribution network."*

Use of cross-border K&I sourcing in different sectors

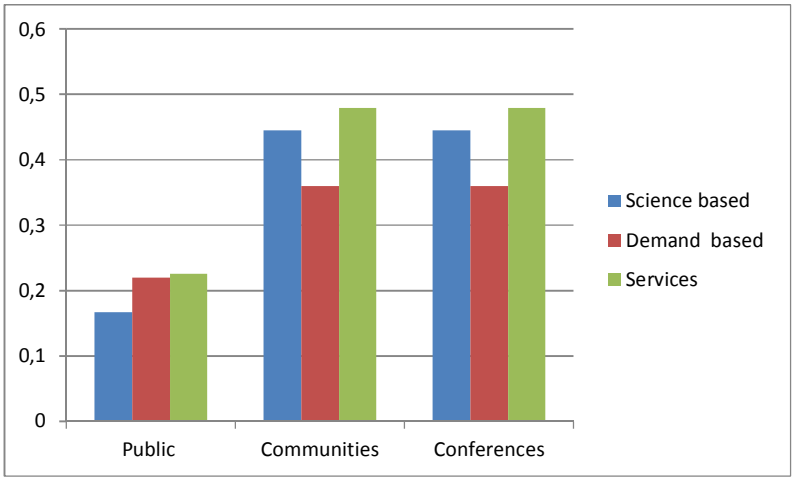
Direct cross-border sourcing



The studied industries are divided into groups according to the nature of the innovation activity in the sector. Biotechnology and medical devices belong to the science-based, high-technology group, whereas mechanical engineering and electronics have more demand-based innovation activities. The technical services sector is dealt with individually. Appendix 7 divides direct sourcing mechanisms to short-, medium- and long-term mechanisms. The above figure clearly shows that the science-based firms are more active in longer-term cross-border collaboration than the other two sectors. It seems that the technical service firms prefer medium-term K&I sourcing mechanisms, such as co-creation, which is the main innovation model in the service sector. However, for the other sectors, partnerships and co-development are also important means of sourcing knowledge.

Knowledge is not always available only through formal contract-based channels. Access to important innovation knowledge may also be gained via informal means, such as attending conferences, seminars and tradeshows. As the figure below demonstrates, public programmes, such as participation in the centre of expertise activities, are utilised the least compared with participation in networks and communities and the aforementioned conferences (see the division of indirect channels in Appendix 7). In particular, science-based firms tend to form their foreign networks themselves rather than rely on public initiatives in this regard. However, we could say that these firms are perhaps more engaged in international networks since the beginning of the firm life cycle than the firms in the metal sector. Therefore, science-based firms are able to adapt to significant foreign innovation knowledge easily.

Indirect cross-border sourcing



Innovation collaboration in the studied case firms

Table 15 provides information on the innovation sourcing practices of the case firms. The division of practices into three main phases of the innovation process (i.e., idea generation, development and commercialisation) shows that majority of the cross-border sourcing and collaboration is related to commercialisation. This development is a natural one, as the markets targeted by most of the innovations are global, and creating sales channels requires face-to-face contacts. Furthermore, the majority of customer feedback and ideas for new applications are received through these networks. The science-based innovative companies also need to maintain strong relations to domestic and foreign universities. Although all of the interviewed firms stressed the importance of regular cooperative relations to academia, many could not maintain these relations, mainly because of human or financial restrictions.

Table 15. Description of the (foreign) K&I sourcing practices in the case firms' innovation processes.

	Innovation description	(Foreign) K&I sourcing practices in the innovation process			Internationalisation
		Knowledge sourcing for research and idea generation	Knowledge transformation for (product) development	Knowledge exploitation for commercialisation	
Case A	BonAlive is a synthetic and bioactive bone void filler with unique antimicrobial properties. It is a relatively new product. Its markets are niche and global. The market needs to be created for various applications, which means that surgeons and doctors must be trained to apply new bioabsorbable materials and products instead of traditional materials. Clinical tests started in the late 1980s, and the innovation's first applications were available in the early 1990s. The first BonAlive innovation was commercialised in 2004.	Bioactive glass basic research is conducted in close cooperation within a network of local universities in Turku. A strong collaborative partnership with the University Hospital in Austria. Regular contacts to many foreign universities, mainly in Europe. Engaged in traineeships with universities.	Applications require close multidisciplinary research. In 2011, the innovation had 2–3 application areas. Ideas for new applications come from customers (i.e., surgeons) (both domestic & foreign). International production network: bioglass production in Finland, product sterilisation in Belgium (outsourcing), testing in two places in Switzerland (outsourcing), mould production in China (subcontracting), assembly in its own facilities in Finland.	Close collaborative partnerships with University hospital surgeons, who are the lead users. Some of the distributor relations are stronger, largely because of the distributor's personal contacts and know-how. Social networks created in trade fairs, customer visits and academic (medical) conferences.	In 2008, three foreign distributors and one large domestic customer (80% sales). From 2010 onwards, the development of a worldwide distributor network. In 2011, some 20 foreign distributors.
Case B	Innovation is based on a physics invention of the electro-mechanical film (EMFi), invented in the early 1980s. Innovation is applied in directional audio solutions, one of which is Sound Shower®. Products are ideal for banks, retail stores, museums and other places where sound needs to be directed. Innovation is sold in two ways: by employing distributors and resellers	The original invention was developed into an application with VTT in the early 1990s (with Tekes funding). No formal foreign collaboration. Some R&D cooperation and contract R&D with large companies (national & international).	From 1998 to 2002, a production line with internal resources was developed, as no readymade machines were available. Test marketing (piloting) started in 2003. New application areas are developed (e.g., in EU or Tekes-funded research projects in a consortium of domestic & foreign universities, which conduct basic	Commercialisation of first innovation in 2004. The first customers were domestic, but in the same year, the first foreign deal was also signed. Consultants (foreign & domestic) help in system selling. Foreign partner relations are formed through the sales of system integrators. These contacts produce customer needs. Participation in 1–2 international trade (mainly in Europe) fairs per year to	The main market areas are Europe and the US. Asia is a potential market in the future. The US subsidiary/sales office was established in 2007. The European sales office was under planning in 2011. Products have been sold to approximately 36 countries by 2011.

	(plug & play products), by licencing technology and by providing solutions in larger systems.		and applied research on the use of planar sound).	increase visibility and the (social) network. However, deals are made through personal selling. 2nd generation products on the market in 2007. Three new product leases are expected in 2012.	In 2011, large systems were delivered to US grocery store chains in the US & Canada.
Case C	The innovation originated from Tekes's technology programme on light sheets (KENNO). The firm was established to produce laser-welded sandwich elements. Although the production technology is narrow, application areas for the innovation are vast and range from ballistic protection products to elevator floors.	Top knowledge on sandwich structures and light structures is located in Finland, both in the maritime industry and academia. Participation in, for example, technology programmes in a consortium with national universities (mainly LUT in laser welding) and VTT to gain information. Cooperation with material producers on raw material aspects. Cooperation with Minnesota Technical University in 2006 on steel sandwich roof panels for housing.	Own production line was built with the help of newly recruited experts in 2005. From 2006 to 2010, cooperative development was conducted with the Finnish Armed Forces. Some design services have been subcontracted from domestic firms. Trade fairs and seminars are used as an information source and for networking purposes. International collaborations were conducted through the CleanTech Finland network. However, participation in these activities is highly dependent on the financial situation. Contract R&D for (domestic) customers. Thesis workers (3) from local universities.	First domestic pilot projects in 2003. The direct customers are mainly domestic, but many integrated products are exported. Since 2011, the share of ballistic products in production is increasing. International standardisation was performed in cooperation with Dutch and French shipping firms.	Some small-scale and prototype deliveries abroad during several years. Discussions with Swiss Casale SA about considerable orders for industrial plate heat exchanger elements in 2012.

Importance of internationalisation objectives to SMEs

When we inquired about the companies' internationalisation objectives for the years 2010–2015, 70% of the SMEs mentioned that starting cooperation with a company outside of Finland is of high or medium importance to them. Establishing a strategic partnership with a foreign company is the second most important objective (63%), and starting export activities (if not already exporting) is the third (56%). Starting cooperation with a foreign company and establishing a strategic alliance with it was especially highlighted by the biotech companies (85% in both groups, internationally and domestically operating firms) and technical service companies (70%). Approximately 60% of the biotech companies responded that starting collaborative activities with a research institute or university abroad is of medium importance to them. Establishing or acquiring a R&D unit abroad or outsourcing R&D or part of it to their own subsidiaries or to external companies abroad was mentioned only in a few cases. Approximately 30% of the SMEs mentioned that establishing or acquiring a foreign unit (e.g., production or sales unit) is of high or medium importance to them. In addition, introducing new K&I sourcing and transfer mechanisms was seen as important by approximately 30% of the respondents. This point was highlighted especially in technical services. Therefore, it seems that innovative SMEs are not thinking of engaging in outsourcing; rather, they use channels that they can better control to access and source important K&I knowledge while internationalising their operations at the same time. (See Figure 17.)

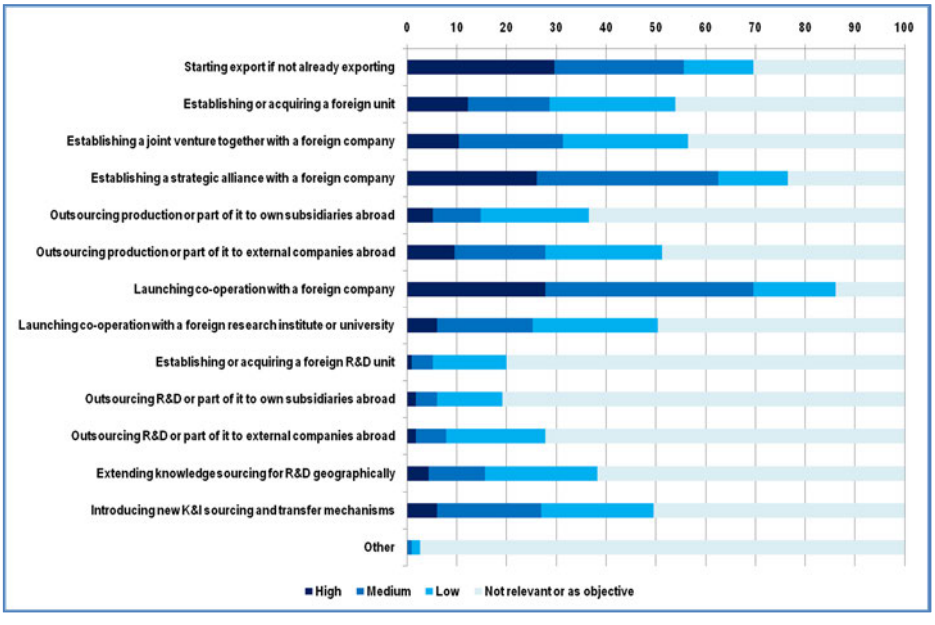


Figure 17. Importance of internationalisation objectives for 2010–2015; % of respondents (N = 115).

9. The role of policies and external conditions in international activities of companies

The aim of this chapter is to outline the relevance and effects of external conditions and policy support mechanisms, to identify bottlenecks and good practices in these conditions, and to assess how these processes and effects influence specific industrial sectors, the national contexts of the companies, and technologies and related knowledge areas.

9.1 Innovation environments

Innovations are the result of cooperation among many actors. Cooperation can only come about in a fruitful innovation environment. In an ever-more complex world with fewer borders, the production of innovations needs more multidimensional networks in which knowledge, skills, abilities, needs and interests can connect. An innovation environment provides opportunities for such encounters and the development of innovation networks. Many innovation policy measures focus precisely on developing such an environment. Dynamic, genuinely innovative environments are the best conditions for attracting international actors to Finnish innovation communities (Ahvenharju et al. 2006).

An innovation environment contains the framework and criteria for an innovation system, such as a viable labour market, a research, education and training system, intellectual property rights, business and market legislation and reliable social institutions. However, an innovation environment has many other dimensions in addition to the basic structures and rules of an innovation system. A key factor is physical location. An innovative company is tied to its global, national and local environments in many ways. For innovation networks to emerge, the actors often have to be close to one another. Trust is built on direct and close interactions. Local poles of excellence help companies and research organisations to find one another and establish new innovation communities. In a borderless world, local clusters are not enough. An innovative environment seeks and establishes links to the places where the necessary knowledge and skills can be found. Finding suitable connections is hard work. For that reason, we need support and intermediary organisations to help innovation communities and networks to find the

information and contacts they need globally (Ahvenharju et al. 2006) (see Appendix 8 for the key actors supporting internationalisation in the Finnish innovation environment).

The external conditions experienced by firms may explain why international R&D collaboration is undertaken. These conditions can be grouped into those facilitating international R&D collaboration – the so-called pull factors – and those creating a need for firms to cooperate across national borders (i.e., push factors). One of the pull factors is the improved manageability of cross-border collaboration due to reduced transaction costs. These reductions are related, for instance, to the introduction of ICT, the harmonisation of regulations, and the reduction of trade, investment and other barriers as a result of growing economic liberalisation (Ahvenharju et al. 2006).

Even traditional manufacturing firms are now recognising that their products will find a differentiated, value-added role in a growing economy only if they can utilise the expanding world of advanced technology services. Medium-tech industries such as the automotive, chemical and (partly) the machinery and metal product industries are consolidating, increasing productivity, and streamlining their development processes. However, they are still largely stuck in a slow-growth environment with strong competition. In mechanical engineering, it is increasingly popular to build up cooperation networks that produce customised total solutions to customers. It is obvious that this sector has yet to realise the potential benefits of internationalisation.

The high-tech and knowledge-intensive industries, such as pharmaceuticals, ICT technologies, biotechnology, medical engineering and increasingly technical services, are already highly globalised and face strong global competition. Biotechnology is most reliant on frontier knowledge and close networking with global centres of excellence. For biotechnology, framework conditions (regulations) are crucial for location decisions, and SMEs are highly specialised suppliers or standalone companies. In medical engineering, small and young firms are the most innovative and research intensive, and they are inclined to cooperate with large companies. They also operate in highly regulated markets with established international standards and market accessibility. In consumer electronics, technological innovation is crucial for the competitiveness of local manufacturers. For these SMEs, joint ventures and cooperation are common, and SMEs are mainly suppliers to large companies. Technical services, for their part, play a key supporting role in sustaining and enhancing the performance of other manufacturing and services industries. For mechanical engineering, a traditional “craft” method-based manufacturing industry, and for technical services, further benefits of internationalisation are still expected.

Three critical industries, computer and software, telecommunications and consumer electronics, constitute the so-called information revolution. The information revolution has played a unique role in transforming R&D because it is both a driver and a beneficiary of advances in R&D. Information technologies have changed the way business is done in virtually every industry. Firms reorganise themselves around communication flows and open new ways for customers and consumers to

use ICT technologies to cooperate and shop in a variety of settings. In addition, because of the ICT technologies, firms can operate on a global scale with a rich set of partners and still downsize their central staff. Advances in information technology, communications, and software have influenced key strategic decisions for a number of companies (Hirshfeld and Schmid 2005).

9.2 Policy framework and support

As both the business environment and the knowledge creation become increasingly global, SMEs are also acting in a global environment, and their activities, including R&D, are increasingly crossing national boundaries. Consequently, the international dimension should be a natural part of all innovation and growth policies in a global economy and could receive more explicit attention. To date, existing innovation and technology policies have been largely national. Quite recently, more emphasis has been placed on supporting the internationalisation and international networking of the knowledge-intensive growth-oriented businesses. There is a real need to combine the sourcing of the market and customer knowledge with the R&D and the development of business operations (TEM 2009a).

SMEs are at the centre of innovation policies within Europe. However, although gaining recognition in national ministries, SMEs' engagement in international knowledge and innovation activities has received limited support. In contrast, their engagement in export activities has been widely embraced. Similarly to Finland, most of the countries studied by Ahvenharju et al. (2006) have only a few concrete policy measures to promote and support the international R&D of SMEs, such as access to international innovation networks. Typically, support measures for internationalisation do not explicitly account for R&D activities. Moreover, the instruments for R&D activities fail to address internationalisation needs. However, many European governments have recently recognised the need to include additional international perspectives in their innovation policies.

In practice, policy measures in most of the countries emphasise the importance of inward flows of both capital and human resources, and it appears that the benefits of stimulating home-based SMEs to collaborate internationally in R&D are not acknowledged to the same extent. Furthermore, as noted by Ahvenharju et al. (2006), the discussion on innovation policy should better acknowledge the existence of different types of international R&D in SMEs. In addition, the accumulation of knowledge capital in the home country and the production of value added to customers are dimensions in the broad-based innovation and internationalisation policies (TEM 2009a) that should be in the focus of innovation support as well.

In Ahvenharju et al. (2006), R&D activities were divided into three categories, which differ from each other in terms of the forms and drivers of international cooperation:

1) Close-to-market R&D is related to meeting specific, short-term customer needs through, for example, customisation and localisation projects. This type of R&D includes intensive international cooperation, and the partners are also often business partners.

2) Core R&D is related to the long-term development of the core product technology. In this case, cooperation tends to be limited, and national partners are often the primary choice. The main driver of international contacts is access to top-level knowledge – the potential partners represent a wider variety of organisations and range from companies to universities.

3) Supporting R&D includes tasks outside of the company's core competence, such as the outsourcing of non-core software development. The driver of outsourcing is the allocation of in-house resources to core activities. The international dimension is most often linked to lower cost levels in other countries.

However, although not comprehensively covered in Finnish innovation policies, some national programmes target SMEs for international K&I activities, such as Tekes's programme for young innovative companies or the holistic Team Finland concept that is currently under preparation (Team Finland report 2012). Furthermore, some programmes are found at the European level as well, which, according to the available European information sources on national programmes (e.g., Trendchart and Erawatch), unfortunately do not provide a positive picture, as the international dimension still does not play a major role. In addition to national intermediary organisations, associations and programmes, one major source of support is the European Framework Programme (FP), which has seen an increase in SME participation over time (EPEC 2006), before the numbers dropped for FP6 (Marimon et al. 2004). The programme is obviously limited to European (and a few extra-European) collaborations, and the broad array of further international K&I activities is not systematically targeted.

New schemes, especially the Technology Platform, that enable SMEs, in principle, to engage in long term, strategic, European coordination are now being tested. In addition, the Eureka's Eurostars funding programme, which targets the international collaboration of innovative SMEs, was launched in 2007, which indicated a clear, growing need for SMEs to engage in transnational, long-term collaborations. The European Union's support programmes for the internationalisation of SMEs beyond cooperation in the framework programme are generally limited to offers of assistance by intermediary organisations and/or public authorities to help SMEs access markets outside of the EU. Examples of these overwhelmingly indirect support measures are country-oriented programmes such as Asia Invest (Asia, excluding Central Asia) and AL-Invest III (Latin America).

In Finland, there are support programmes that encourage SMEs' international cooperation and create proactive internationalisation strategies (e.g., Tekes) (see Helsinki School of Economics/LTT 2007). Hence, as the ERANET activities in Europe and recent national initiatives show, national policymakers and programme leaders are increasingly aware of the need to facilitate international programme funding. The dynamic here seems obvious, but what form this support will take and how those policymaking opportunities account for the specificities of sectors and technologies remains to be seen. It is clear, however, that the general policy framework and specific supporting measures will influence the opportunities of

SMEs to participate in international K&I transfer. In turn, a well-informed internationalisation policy would need to have more knowledge about the specific needs, challenges and potentials of SMEs as one important pillar of the national innovation environment.

The results of our survey indicate that SMEs widely tap into a domestic knowledge pool, collaborate and use other knowledge channels. Therefore, public incentives must first ensure that the domestic knowledge resources found, for example, in the universities are of top quality. Conversely, for some innovative SMEs, especially science-based firms, the domestic knowledge repository is not adequate, and participation in global knowledge networks becomes a prerequisite. The cutting-edge technological and scientific knowledge that these companies are pursuing does not necessarily lie in Finland. However, the university sector in knowledge transfer did not receive unquestionably positive feedback in the conducted case interviews, as the following quote demonstrates.

> *"…we should really discuss how we can really ensure that knowledge spills over to industry. It remains in the universities and research organisations too often. Good knowledge is produced but does not spill over."*

9.3 Promotion to create national benefit

There seems to be a general view in the innovation policy literature that governments should promote international R&D collaborations and that these activities are thought to generate national benefits. Government policies should help SMEs to overcome the barriers of international R&D collaboration. Hence, policies need to be based on a good understanding of the different barriers and needs for collaboration. The general observation is that many policy measures touch upon international R&D collaboration elements, but few are directly focused on promoting these activities (e.g., by providing up-to-date information for SMEs or by helping SMEs to access foreign networks). According to Ahvenharju et al. (2006), the main missing element is an international focus on innovation support. Providing an international dimension in general measures oriented towards R&D collaboration seems to be the most effective tool.

According to Ahvenharju et al. (2006), three types of benefits to society are generated by international R&D collaborative activities:

1. strengthened competitiveness accruing to the national unit,
2. increased technological intensity,
3. spillovers and knowledge transfer.

If firms invest abroad in location-specific advantages, the home nation loses a technological opportunity that might not be compensated by the strengthened competitiveness accruing to the national unit. The home nation could try to regain the opportunity by improving its own location advantages. For governments to

secure increased technological intensity by means of inward flows, they need to create an innovative environment with attractive firms while protecting the target companies from predatory acquisitions. Currently, many innovative SMEs are sold too early and for too low a price.

The policies for attracting R&D or knowledge-intensive units from abroad relate to measures aimed at strengthening the scientific and technological capabilities of a country and preventing discrimination against foreign firms. The technology programs in a country may serve as platforms for attracting international experts and foreign firms. With regard to inward out policies, measures to link domestic firms to foreign knowledge may include financial support for R&D abroad. This measure has been rather seldom used to date. Various measures that promote international and national networking and that help to establish international contacts are more common.

The participation of external investors was seen beneficial to the innovative SMEs in our study. The underdevelopment of the Finnish private capital market has been criticised by many (see, e.g., TEM 2009b), and a clear improvement in that sector is needed to provide not only foreign financial resources but also the expertise of investors on the progress of innovative SMEs. It is commonly known that the Finnish business environment lacks the culture of serial entrepreneurship. This absence also hinders the development of managerial talent, which would eventually trickle into innovative small businesses.

The policy measures with respect to R&D globalisation can be divided into three groups:

1. policies designed to attract R&D units from abroad,
2. government measures designed to link domestic firms to knowledge from abroad,
3. policies designed to promote the mobility of human resources (Luhtala and Åkerblom 2006).

Many policies aim to stimulate the import of foreign talent. These policies relate to the elimination of barriers to immigration, income taxation, the accreditation of foreign qualifications, improvements upon legislation on S&T and the reduction of cultural and structural barriers. However, gaining acceptance for funding researcher positions in industrial firms may be far more difficult than gaining acceptance for tools because such acceptance would essentially require industrial firms to fund research at universities or institutes, that is, public funding for public knowledge accumulation (Herstad et al. 2010). Transnational human capital flows refer to foreign experts, expatriates, and international and foreign students, but they can also be accrued from cooperation and collaboration with international partners (Kautonen and Raunio 2010).

The task of the Ministry of Employment and the Economy is to promote exports of Finnish enterprises to ensure that they have at least equal internationalisation conditions and operating possibilities in the market compared with the companies of competitor countries. Public export promotion services are primarily provided for SMEs. Through public services and subsidies, the Ministry strives to encourage

enterprises operating in the home market to internationalise their businesses. Additionally, the Ministry aims to accelerate the internationalisation process of enterprises that have already started exporting. For instance, the services of Finpro are mainly targeting these businesses.

It is also the task of the Ministry of Employment and the Economy to build a modern growth entrepreneurship policy that creates first-rate conditions for Finnish growth ventures. Growth can be encouraged, for example, by providing tax incentives to entrepreneurs, investors and companies and other relevant forms of regulation, by increasing the amount of financing available for growth and internationalisation, by tailoring public business services and business incubation projects based on the needs of growth companies, by developing the general entrepreneurship culture, and by strengthening the linkages between research and entrepreneurship. The aim is to build a national, world-class innovation ecosystem that encourages innovation and new, ambitious, competitive business ventures. Innovation and industrial policy has the potential to influence the conditions for growth and the number of growth companies. Together with Tekes, the Ministry of Employment and the Economy concluded a few years ago that more needs to be done to acknowledge the growth company perspective in different policy areas, particularly in innovation policy. If industrial production is gradually transferred to other countries, the generation of new growth enterprises and promotion of entrepreneurship becomes increasingly important. Generally, public support is seen as an important enabling factor, especially at the early stages of a company (Ahvenharju et al. 2006).

The current innovation policy increasingly sees innovation as a systemic process, where basic research, applied science, corporate R&D and commercialisation interact. Hence, the support needs are also understood more broadly than earlier. At the same time, the discussion has shifted from direct intervention to the development of the innovation environment, although direct intervention has not been forgotten. The importance of joint ventures and service integration among the various organisations providing support for SMEs has recently been emphasised. The need for streamlining the various support services has also been identified in a recent report evaluating the Finnish enterprise support system (Team Finland report 2012).

One recent trend has been the emphasis on business development skills, including support measures for technology and knowledge-intensive enterprises to improve their business plans and their management of marketing, exporting and networking. However, the extent of these support instruments is limited by the de minimis rules, which restrict the market interference of government support. The lack of customer-driven innovation and the challenges related to service sector innovation have also been acknowledged. Despite these trends, Finnish innovation policy can still be seen as highly technology- and technology push-oriented. Ahvenharju et al. (2006) concludes that in the current context, more emphasis could be placed on indirect support that facilitates the international activities of SMEs: experienced civil servants could act as facilitators, mentors and matchmakers between potential partners and information sources.

This conclusion is also supported by the results of this study, as we see that innovative SMEs are more likely to use informal channels to access and transfer

knowledge from foreign sources than to use, for instance, more direct cooperative forms. However, we also share the view that external investors, with their engagements and experience, could act as facilitators and matchmakers instead of civil servants. As highlighted in the workshop organised by our research team, we already have quite a public-oriented innovation system in Finland. The system should be made more flexible, and services should be differentiated for different groups of SMEs. Financial support for promising endeavours (e.g., for handling regulatory processes and even for finding the first reference) should be made more flexible. Traditional instruments are not enough anymore.

Additionally, many of the interviewed case company representatives believed that the support for commercialising innovations (i.e., the phase of finding the first reference and customer) is neglected in the innovation support system.

> *"I have tried to find the means and funding for it (construction of an international sales network), but I've not really found any good means…"*
>
> *"When we have developed an idea into a product and it needs to be commercialised, then are inputs to marketing so fundamental. So, if you support R&D, why stop when you need to commercialise? This is when the support is needed here in Finland. And we don't know this properly*."

At the same time, Finnish SMEs are working too much for themselves and are reluctant to engage in open innovation because of their few resources and limited expertise in IPR issues. In this respect, there is an obvious need for external services. It was also noted that money is not always the best means of enhancing innovation. As stated in the workshop of this study, "research makes knowledge from money, but companies make money from knowledge". Supporting cross-border knowledge sourcing by different means is vital for the increasing number of SMEs in the global business environment and the world of knowledge creation.

9.4 Challenges

Despite significant investments, the Finnish innovation system produces fewer new companies aiming at rapid growth and internationalisation, and there is little desire among active companies to grow when compared with companies in other countries. Finland has strong knowledge potential based on substantive R&D investments from both the public and private sectors. However, this potential does not generate enough new products and services to the global market (GEM 2010). Moreover, the participation rate of Finnish SMEs in the EU Framework Programmes is under the average compared with the other EU countries (Grönroos 2010).[34]

[34] The share of SMEs among the Finnish participants is 13.5% (Grönroos, Presentation given at the SME-info, Tekes 5.9.2010).

The knowledge about the methods and tools of internationalisation and commercialising results and innovations may not be at an international level in the Finnish supplier and partner networks. Mainly, there are deficiencies in attitude, as several innovative companies are run by inventors who might lack business attitudes and business knowledge at the same time. Additionally, the indigenous companies may not have the same capabilities to benefit from cross-border business opportunities as their foreign competitors that are located closer to each other. To some extent, the Internet has facilitated the global operations of SMEs. However, the challenge lies in finding relevant international partners or firms that provide technical services and determining how to enter a phase of sustainable growth as soon as possible to prevent competitors from take contracts.

Finland is a regionally and culturally peripheral country, and, as noted by Narula (2002), the relative ease of identification, establishment and maintenance of domestic linkages (compared with international ones) may cause not only a lock-in situation but also, from a territorial innovation system perspective, suboptimal exposure to diversity. Herstad et al. (2010) go further and warn that an excessive, singular focus on localised learning from the policy system may be harmful. Systemic failures may result in inadequate linkages across organisational boundaries or in lock-in to specific collaboration partners or sources of ideas and information.

Conversely, an excessive or unbalanced focus on knowledge and innovation created in international knowledge development nodes may also be harmful. International networking should be supplemented by increased incentives for the development and accumulation of specialised, synthetic knowledge by enterprises. The challenge for policy is to support the domestic embedding of internationally linked industries, which, through these linkages, develop specialised knowledge that spills over into their surroundings and by way of diffusion − again supported by policy − is recombined and transformed. Therefore, policy should compensate for, not reinforce, incentives to substitute internal R&D with external sourcing. Hence, public policy should focus on the build-up and maintenance of the private sector's organisationally embedded knowledge bases (Herstad et al. 2010).

For the SMEs in Finland, the focal question may ask, "Are there incentives for the formation of international linkages in various forms?" National R&D incentives are increasingly open to international companies, universities and research organisations, but are they also open to the domestic companies located in a host country? The outcome is contingent on both domestic intramural R&D (gravitational pull and absorptive capacity) and on domestic linkages (diffusion into the domestic economy). For example, the mobility of top management between industry and business allows enterprises to transform and position themselves according to the requirements set by other industries and competition. Management mobility is an important channel of knowledge spillovers (Seppälä 2010). This fact should especially be acknowledged in countries such as Finland, where serial entrepreneurship is lacking compared with, for instance, the US. Linkage support must balance between building narrow, heterogeneous and broad interaction patterns (Herstad et al. 2010).

In terms of funded R&D projects that support international linkages, we can distinguish between international projects (e.g., EU-funded programmes) and national projects allowing or even requiring international participation. International projects are seen as the most appropriate vehicle for establishing international linkages. However, they come with the disadvantage of large consortia, and it is difficult for individual firms to establish themselves as the focal points in these projects (Herstad et al. 2010).

Herstad et al. (2010) argue that a 'loosening up' of what, at present, is a strong policy that emphasises containing interactions within national boundaries and focusing on science-industry linkages is necessary to avoid negative technological lock-in. The purpose of external linkages is to feed into knowledge development processes and therefore, through spillovers, expose territorial innovation systems to diversity beyond what they can generate endogenously. However, the ultimate purpose of national-level innovation policy is not international, national or regional linkages per se. Rather, the objective is the development and maintenance of territorially embedded knowledge bases upon which industrial development may continue to build.

10. Conclusions

This publication concentrates on the sourcing of international knowledge and innovation in SMEs instead of discussing the internationalisation of SMEs' operations. Although these two concepts are highly interrelated and cannot be separated in practice, for the clarity of the conclusions, this division is to be maintained.

Because of global competition, the significance of international innovation knowledge is continually increasing in Finnish companies, particularly SMEs. We found in our pilot survey that 60% of innovative SMEs – most of the firms in the survey are independent micro firms – collaborated for innovation with a foreign partner. The shares of cross-border collaborators, which are nearly the same (approximately 57 %) in the mechanical engineering and technical services sectors, are double the share for all firms in the CIS surveys. Approximately 40% of innovative SMEs have co-developed product, service or process innovations together with their customers located outside of Finland. If all international activities (i.e., activities related to overseas market presence (including exporting), production and R&D activities) in 2006–2008 are considered, two-thirds of the innovative SMEs are regarded to have international business activities. From these figures, it is clear that even the smallest firms understand the importance of accessing, transferring and utilising knowledge and know-how originating from foreign locations.

We can state that the innovation processes in SMEs are open in the sense that these firms collaborate in innovation, though most of their partners seem to be domestic. Furthermore, the knowledge is accessed via informal channels, especially in the cross-border context. Although personal relations and social networks play a crucial role in these resource-scarce smaller firms, domestic collaborations have a more formal character, and strategic partnerships are common.

The networking aspect of knowledge sourcing is already covered in various public cluster programmes that aim to provide SMEs access to both domestic and foreign knowledge networks. Given that most of the R&D cooperative relations, especially in the initial stages of the firm, are formed with domestic actors, a sufficient knowledge transfer should not necessarily be sustained only in the SMEs. Rather, the policy should pay attention to strengthening the knowledge pool of the domestic research organisations and universities instead. To maintain an efficient domestic knowledge pool, policymakers should not neglect the inward flow of knowledge, as foreign investments may, at best, enhance the domestic innovation

arena even further and, in particular, help the innovation culture to become more open. However, this effect should be treated with caution, as some of our evidence indicates that just the opposite has unfortunately happened in certain cases.

In addition, the life cycle of the firm has a huge impact on the knowledge needs of an innovative SME. Firms in the early R&D phase may be looking for local partners instead of foreign ones. As the firm proceeds to the commercialisation phase and prepares to launch an innovation on the foreign market, foreign contacts and expertise becomes topical. We can also observe that different types of knowledge sourcing methods are used in the different phases of the innovation process. For instance, contract-based agreements prevail in the early stages of the firm, whereas joint venture arrangements become attractive in the later stages of the company life cycle. Thus, the policies and public subsidies aimed at internationalising the innovation activities of SMEs should be available in the different phases of the firm life cycle. It is generally known that the current R&D subsidies cover the beginning of the innovation process fairly well but that the need for external knowledge does not stop with the development of a technology. The innovations are to be launched onto the market as well. Hence, the true bottleneck for many small innovative firms is to find the first reference. Could the piloting phase be subsidised in some way as well?

However, as we are, in principle, discussing the open innovation practices of firms, we should also remember to extend the openness discussion to the other actors of the innovation environment (e.g., to the decision makers). The openness of firms' innovation activities requires open policy subsidies (e.g., the possibility to include (and subsidise) foreign partners in a firm's R&D projects). The 'closed' R&D incentives that protect the transfer and accumulation of national knowledge may be outdated. We should instead promote knowledge sharing, which impacts both parties and has spillover effects on both nations. The second group of actors in the innovation environment is private investors, whose role as knowledge carriers is critical. In addition to financial resources, these persons are able to provide both business and technology expertise that cannot be necessarily channelled via civil servants. To enhance this capability, policymakers should create incentives to increase the number of serial entrepreneurs.

The largest challenge for SMEs in advancing cross-border knowledge sourcing and open innovation is resource scarcity, especially in R&D. The location of knowledge seems quite clear to innovative SMEs, but the problem is accessing this knowledge. Here we are mainly referring to scarce resources in the form of R&D personnel whose main task would be to coordinate and tap into external knowledge. To provide SMEs more resources, policymakers could provide tax incentives to strengthen innovation resources by recruiting additional R&D personnel. In fact, this policy has a double impact on the firm, as the absorptive capacity of the firm is also likely to increase, which is a crucial aspect of being able to utilise and combine externally sourced knowledge. Now, SMEs are facing too many financial restraints, which make them too vulnerable, as there are insufficient resources to conduct extra R&D in many firms. Often, they need to concentrate on 'daily operations' only.

It is evident that innovation activities differ among industrial sectors and among size classes of firms and that different firms have different needs for the use of external knowledge in the innovation process. For example, biotechnology firms are more naturally connected to foreign innovation knowledge production than mechanical engineering firms, which might find domestic expertise more easily. However, access to the foreign innovation knowledge arena is not important to all firms; rather, the necessity varies. Most firms are still able to develop breakthrough innovations with their internal resources and knowledge, but there are also industries where innovations are more systemic, which means that the actors should engage in co-development since the beginning.

However, it seems that there are currently no such mechanisms on the market that would directly enhance the foreign knowledge sourcing of small businesses. Rather, the internationalisation of innovation activities is expected to be conducted via domestic networks. Furthermore, the commercialisation phase of the innovation is unrepresented in current public innovation subsidy offerings. The majority of the incentives target SMEs seeking international growth (i.e., companies whose business plans and innovations are already finalised).

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Appendix 1: Basic data on innovation-active firms

A first rough characterisation of innovation-active firms and sectors can be performed by analysing the most relevant Community Innovation Surveys (CIS), the annual R&D Surveys, the PATSTAT database on international patenting, the Foreign Affiliates Trade (FATS) Surveys, the Surveys for International Trade in Services, the International Sourcing Survey and the Finnish Innovation Database (SFINNO).

Community Innovation Surveys

By using the CIS, we can obtain a first impression regarding the internationalisation of innovation activities as it concerns innovation collaboration and knowledge sourcing. As the CIS also covers factors that are hampering innovation activities, we can also obtain preliminary information on the sector-specific nature of the barriers to innovation. Using the CIS data for an exploratory exercise on characterising the sectors has several advantages:

- The survey can be used to characterise the analysed sectors. As the CIS survey also contains information on other sectors, the findings in the analysed sectors can be put into the context of other sectors.
- The survey is available for all EU27 countries. Hence, the sectorial analysis can be put into an international context.

However, the CIS data are only sufficient for a rough overview and for generating hypotheses that will have to be tested with the original survey data. As with most surveys, the CIS is not detailed enough to shed light on our research questions (e.g., collaboration for innovation and knowledge sourcing is only captured by dummy variables in the CIS). More detailed information on the collaboration intensity is not available. Fortunately, however, the Finnish edition of the CIS does include the valuation of the collaboration partners. Still, the innovation survey only covers a few aspects of the analysis in this study. In addition to the lack of detail, the survey does not cover all companies, especially the smallest ones, in a given sector, as it is based on a sample. Some important details may be lost because of the sample nature of the survey.

International sourcing survey for 2001–2006

A second relevant survey that has been used here to characterise the sectors is the International Sourcing Survey conducted by Eurostat together with Statistics Finland and four other NSOs (Denmark, Netherlands, Norway, Sweden)[35]. This

[35] www.dst.dk/publ/interSoursing.

survey includes data on the levels, impacts of and motivations for international sourcing among European economies. These data are needed by policymakers, researchers and data users. The survey covers a sample of non-financial business firms. It shows that an increased fragmentation of the value chain allows the business functions of enterprises to be moved abroad totally or in parts in search of lower costs, efficiency gains and/or access to skilled labour and new markets.

Enterprise group register and foreign affiliates trade surveys

The Enterprise Group Register includes annual data on groups' turnover, balance sheet totals and numbers of employees. In addition, information is recorded about the structure of each enterprise group: its group head, the subsidiary companies, the joint venture companies, the associate companies and their Business IDs, the group head's shares of ownership and votes in group companies, the start and finish dates of group relationships and the type of group membership. Recently, mandatory surveys directed to most of the enterprise groups operating in Finland with affiliates abroad were launched to obtain information on the activities of their subsidiary companies, joint venture companies and associate companies. The Outward Foreign Affiliates Trade (FATS) includes data on the activities of affiliates abroad and within the group, such as foreign direct investment (FDI), turnover, number of employees and imports and exports.

EPO worldwide patent statistical database (PATSTAT)

The PATSTAT database covers, for example, the names and addresses of applicants and inventors from the United States Patent and Trademark Office (USPTO) since 1976 and from the European Patent Office (EPO). All regional and international patent applications filed by Finnish enterprises at the National Board of Patents and Registration of Finland (NBPR), at the EPO and through the Patent Cooperation Treaty (PCT) procedure are included. It also includes the EPO master bibliographic database, which contains citations, publications and the patent register for legal data.

As proposed by Archibugi and Iammarino (2002), the shares of exports and international patent applications indicate that firms' in-house technologies are being internationally exploited. Further, they propose that the share of a firm's patents with international inventors and FDI (foreign mergers and acquisitions) indicate the extent to which a firm is engaged in the extrapolation of new technology and innovations abroad (Palmberg and Pajarinen 2005). The worldwide patent database can be used to search for these firm-level data.

Finnish innovation database (SFINNO)

The SFINNO database provides a micro-level insight into the wider processes of industrial renewal and technological change through individual innovations and innovation processes in Finnish businesses. In particular, the goal of the database

is to identify innovative companies, innovations, and the longitudinal and sectoral patterns of innovations. SFINNO is a longitudinal database, with its backbone consisting of some 4,900 individual innovations (mainly product innovations) across the Finnish economy from 1945 to 2009. The entire set entails basic data on these innovations and the firms commercialising them, including variables such as the product group of the innovation, the year of commercialisation, and the sector of the commercialising firm. In addition, survey data on the origins and diffusion of the innovations, the aspects of R&D collaboration, public support, and commercial significance have been acquired since 1985.

Innovations have been collected from articles in technical and trade journals by asking technological experts' opinions and by systematically reviewing the annual reports of companies. Since 1985, data have also been gathered via questionnaires. Complementary data on the commercialising firms have been collected from secondary sources, such as the Business Register and the patent office. A questionnaire is available on the website for firms that are still active according to the Business Register and that have identifiable respondents who have followed the various development phases of the innovation. The questionnaire gives more detailed information on the innovation and the innovation process, and the cover letter defines the innovation as concisely as possible to clarify the object of the questionnaire.

Table. Collaboration in innovation – evidence from the SFINNO data.

	Own concern	Customers	Subcontractors	Suppliers	Universities	Research institutes	Competitors	Consultants
Foreign	28%	48.7%	21%	42.9%	8.1%	11.2%	10%	6.6%
n=	75	544	533	77	532	529	538	527
Domestic	23.3%	67.1%	37.6%	35.8%	28.5%	17.7%	6%	15.5%
n=	583	608	599	134	512	603	586	595

References

Archibugi, D. and Iammarino, S. (2002) 'The globalization of technological innovation: definition and evidence.' *Review of international political economy*, 9 (1), pp. 98–122.

Palmberg, C. and Pajarinen, M. (2005) 'Alliance capitalism and internationalization on Finnish firms'. ETLA Discussion Papers No 991.

Appendix 2: Survey questionnaire

Internationalisation of innovation activities

- By innovation activities, we mean projects or other activities that aim to develop and/or commercialise novel products, services or process solutions, namely innovations.
- By foreign or cross-border countries, we mean countries other than Finland.

1. Company basic information

1.1 Company contact details

Company name	
Company address	
LY-number	
Company NACE	
Contact person	
E-mail	
Telephone number	

1.2 Company background

Has the firm or founder group been a part of any other firm or organisation prior to the company's (see LY-number) establishment?	Yes Firm or organisation No ρ which_____ρ
Is the firm's or unit's (see LY-number) business significantly based on an invention or know-how developed in another organisation (e.g., firms, research organisations, or universities)?	Yes Firm or organisation No ρ to which_____ρ

1.3 Firm position in the value chain or value network

Which of the following levels best describe your company's main position in the value chain or value network from the company's core business point of view? The core business is understood to be the company's main activity.

End-product manufacturer, main supplier The company acts as the end-product or service seller. The company is also in charge of designing and manufacturing. The company gives assignments to contract manufacturers and subcontractors.	Yes ρ
Contract manufacturer, systems supplier The company is in charge of manufacturing and assembling larger entities for the main supplier. The systems supplier can also manufacture end products as the main supplier's assignee (contract manufacturing).	Yes ρ
Subcontractor, equipment or service supplier, components supplier All or a large part of the company's products or services are included in the main supplier's or cooperation partners' products or services.	Yes ρ
Some other role (please specify)	Yes ρ

1.4 Main market areas

Has your company had international business from 2006 to 2008?	Yes ρ	No ρ

2. Firm's innovation activities and innovation cooperation

2.1 Innovation activities

Has your company (see LY-number) had projects or activities aimed at developing and/or commercialising novel products, services or process solutions, namely innovations from 2006 to 2008?	Yes ρ	No ρ

If your company did not have innovation activities from 2006 to 2008, please answer the following questions based on the years in which your company last had innovation activities.

2.2 Innovation cooperation with other actors

Has your company developed and/or commercialised product, service or process innovations in conjunction with the following actors? Please consider domestic and foreign actors separately. Foreign actors are understood to be actors outside of Finland.

	Domestic actors		Foreign actors	
	Yes	No	Yes	No
Customers	ρ	ρ	ρ	ρ
End-product users	ρ	ρ	ρ	ρ
Competitors or other companies in the same sector	ρ	ρ	ρ	ρ
Research organisations or universities	ρ	ρ	ρ	ρ
Component or service suppliers	ρ	ρ	ρ	ρ

2.3 Innovation cooperation with customers

Assess how well the following statements describe your company's cooperation with customers. Please answer "Not at all" if your company has not been involved in such cooperation.

	Extremely well	Well	Fairly well	Not at all
We conduct projects completely specified by the client	ρ	ρ	ρ	ρ
We participate in the customer's development projects as experts	ρ	ρ	ρ	ρ
We carry out the customer's development projects in their organisation	ρ	ρ	ρ	ρ
We participate in designing and preparing the customer's development projects	ρ	ρ	ρ	ρ
We design and prepare development projects on behalf of the customer	ρ	ρ	ρ	ρ
We propose development projects to the customers	ρ	ρ	ρ	ρ
Some other role (please specify)	ρ	ρ	ρ	ρ

2.4 Innovation cooperation with competitors

Assess how well the following statements describe your company's cooperation with competitors. Please answer "Not at all" if your company has not been involved in such cooperation with competitors.

	Extremely well	Well	Fairly well	Not at all
We collaborate with competitors on a pre-competition basis (e.g., standardisation)	ρ	ρ	ρ	ρ
We collaborate with competitors in product and service development	ρ	ρ	ρ	ρ
We collaborate with competitors in process development	ρ	ρ	ρ	ρ
We collaborate with competitors in marketing new product or service solutions	ρ	ρ	ρ	ρ
Some other role (please specify)	ρ	ρ	ρ	ρ

3. Knowledge in innovation activities

3.1 Significance of knowledge sources in innovation activities

Assess the significance of the following organisations as knowledge sources in your company's innovation activities. Please, assess domestic and foreign knowledge sources separately. If a source was not in use, please answer "Not in use".

Knowledge source/ organisation	**Significance – domestic knowledge source**				**Significance – foreign knowledge source**			
	Great significance	Significant	Less significant	Not in use	Great significance	Significant	Less significant	Not in use
Own company or concern	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ
Equipment, materials, components or IT software suppliers	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ
Customers and main suppliers	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ
Competitors or other companies in the sector	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ
Consulting companies, commercial laboratories and private research organisations	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ
Universities and polytechnics	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ
Public and private non-profit research organisations	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ
Public actors (e.g., TE centre, Finpro, Tekes or foreign equivalent)	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ
Other (please specify)	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ

3.2 Knowledge type in innovation activities

Assess what type of knowledge and know-how your company has acquired from the previously mentioned knowledge sources. Please assess domestic and foreign knowledge sources separately.

	Knowledge type – domestic source				**Knowledge type – foreign source**			
Knowledge source/organisation	Wishes, ideas and design	Technological, scientific knowledge; testing and standards	Knowledge of markets and business environments	Knowledge of business models and ways of action	Wishes, ideas and design	Technological, scientific knowledge; testing and standards	Knowledge of markets and business environments	Knowledge of business models and ways of action
Own company or concern	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ
Equipment, materials, components or IT software suppliers	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ
Customers and main suppliers	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ
Competitors or other companies in the sector	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ
Consulting companies, commercial laboratories and private research organisations	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ
Universities and polytechnics	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ
Public and private non-profit research organisations	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ
Public actors (e.g., TE centre, Finpro, Tekes or foreign equivalent)	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ
Other (please specify)	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ

3.3 Significance of knowledge sourcing mechanisms in innovation activities I

Assess how significant the following direct, contract-based knowledge sourcing mechanisms were in your company's innovation activities. Please assess domestic and foreign knowledge sourcing mechanisms separately. If a mechanism was not used, please respond *"Not in use"*.

	Significance – domestic knowledge sourcing				**Significance – foreign knowledge sourcing**			
Knowledge sourcing mechanism	Great significance	Significant	Less significant	Not in use	Great significance	Significant	Less significant	Not in use
Own R&D	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ
Contract R&D (R&D purchased externally)	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ
Acquisition of equipment, materials, components or software	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ
Purchase of IPR (e.g., patents and licences)	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ
Purchase of other knowledge (e.g., market surveys, technological information)	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ
Training (own or purchased externally)	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ
Public services (e.g., TE centre or foreign equivalent)	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ
Co-development and knowledge exchange (project based, including cooperation with research organisations)	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ
Strategic partnerships and long-term cooperation with other companies	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ
Joint venture	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ
Recruitment of R&D personnel	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ
Equity investments in other companies	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ
Acquisition of R&D units or companies	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ
External investors' participation in executive committee	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ
Another direct sourcing mechanism (please specify)	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ

3.4 Significance of knowledge sourcing mechanisms in innovation activities II

Assess how significant the following indirect, non-contract-based knowledge sourcing mechanisms were in your company's innovation activities. Please assess domestic and foreign knowledge sourcing mechanisms separately. If a mechanism was not used, please respond *"Not in use"*.

	Significance – domestic knowledge sourcing				**Significance – foreign knowledge sourcing**			
Knowledge sourcing mechanism	Great significance	Significant	Less significant	Not in use	Great significance	Significant	Less significant	Not in use
Participation in collaboration networks (e.g., social networks)	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ
External informant (e.g., trade promoter and innovation promoter)	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ
Participation in research programmes (e.g., Tekes technology programme and EU Framework programme)	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ
Public special programs (e.g., centres of excellence or foreign equivalent)	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ
Conferences, trade shows and exhibitions	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ
Industry federations and chambers of commerce	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ
Scientific journals and trade journals	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ
Another indirect sourcing mechanism (please specify)	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ

3.5 Geographical distribution of knowledge sources

Assess which of the following regions are the main knowledge and know-how sourcing areas for your company.

Finland	ρ
Euro area	ρ
Other EU state	ρ
Other European state	ρ
North America	ρ
Central and South America	ρ
Middle East	ρ
Asia	ρ
Oceania	ρ
North Africa	ρ
Other Africa	ρ
Other (please specify)	ρ

4. Motives and barriers for cross-border knowledge and know-how sourcing

4.1 Motives for foreign knowledge and know-how sourcing

Assess how significant the following motives were to the use of foreign knowledge sources in your company's innovation activities. By foreign knowledge sources, we mean sources that are located outside of Finland.

Motive	**Significance**			
	Great signifi-cance	Significant	Less signifi-cant	Not in use
Non-availability of domestic knowledge and know-how	ρ	ρ	ρ	ρ
Staying at the forefront of R&D	ρ	ρ	ρ	ρ
Creating new products, services and/or new businesses	ρ	ρ	ρ	ρ
Accessing new markets or cognisance of customer needs	ρ	ρ	ρ	ρ
Increasing market share	ρ	ρ	ρ	ρ
Acquiring technology and/or special know-how	ρ	ρ	ρ	ρ
Moving R&D closer to customers and/or production	ρ	ρ	ρ	ρ
Increasing product or service production capacity	ρ	ρ	ρ	ρ
Extending activities to new sectors	ρ	ρ	ρ	ρ
Focusing on core business	ρ	ρ	ρ	ρ
Smaller R&D expenses	ρ	ρ	ρ	ρ
Following customers and/or competitors	ρ	ρ	ρ	ρ
Other (please specify)	ρ	ρ	ρ	ρ

4.2 Barriers to foreign knowledge and know-how sourcing

Assess how significant the following barriers were to the use of foreign knowledge sources in your company's innovation activities. By foreign knowledge sources, we mean sources that are located outside of Finland.

	Significance			
Barrier	Great significance	Significant	Less significant	Not in use
Distrust in external partner's ability to provide a solution	ρ	ρ	ρ	ρ
Concern over the leaking of a core competency to an external partner	ρ	ρ	ρ	ρ
Concern over the leaking of R&D or technology important to competitive advantage	ρ	ρ	ρ	ρ
Constraints (or regulations) on (re)locating activities abroad	ρ	ρ	ρ	ρ
Difficulty in finding a competent partner	ρ	ρ	ρ	ρ
Majority of know-how is tacit and non-codifiable	ρ	ρ	ρ	ρ
Research or technology is novel, so no foreign know-how is available	ρ	ρ	ρ	ρ
Commissioned R&D or technology is difficult to merge into the company's R&D	ρ	ρ	ρ	ρ
Language and cultural factors	ρ	ρ	ρ	ρ
Other (please specify)	ρ	ρ	ρ	ρ

5. Internationalisation objectives for 2010–2015

Assess how significant the following objectives are to your company in 2010–2015.

Objective	Significance			
	Great significance	Significant	Less significant	Not significant or not as objective
Start exports if not already exporting	ρ	ρ	ρ	ρ
Establish or acquire a foreign unit	ρ	ρ	ρ	ρ
Establish a joint venture together with a foreign company	ρ	ρ	ρ	ρ
Establish a strategic alliance with a foreign company	ρ	ρ	ρ	ρ
Outsource production or part of it to its own subsidiaries abroad	ρ	ρ	ρ	ρ
Outsource production or part of it to an external company	ρ	ρ	ρ	ρ
Launch cooperation with a foreign company	ρ	ρ	ρ	ρ
Launch cooperation with a foreign research institute or university	ρ	ρ	ρ	ρ
Research and development				
Establish or acquire a foreign R&D unit	ρ	ρ	ρ	ρ
Outsource R&D or part of it to its own subsidiaries abroad	ρ	ρ	ρ	ρ
Outsource R&D or part of it to external companies abroad	ρ	ρ	ρ	ρ
Extend R&D knowledge sourcing geographically	ρ	ρ	ρ	ρ
Introduce new K&I sourcing and transfer mechanisms	ρ	ρ	ρ	ρ
Other (please specify)	ρ	ρ	ρ	ρ

Comments on the internationalisation of your company's research, development and innovation activities or this survey

THANK YOU FOR ANSWERING!

Appendix 3: Case study interview structure

1. COMPANY PROFILE

    - Company history and ownership structure.

2. INNOVATION ACTIVITIES

    - What is the company's main innovation (product, process, service)?
    - When was the first innovation commercialised?
    - What are the innovation characteristics (e.g., market perspective and complexity)?
    - Identify the steps of the innovation process.

3. INTERNATIONALISATION

    - When and how was the company internationalised?
    - Identify the main customers, the share of foreign markets, and the main competitors.
    - Which are the current market areas?

4. INNOVATION SOURCING /R&D COLLABORATION (innovation knowledge identification, transfer and absorption)

    - Does the firm have a technology/R&D cooperation strategy?
    - Motives for R&D collaboration? Main challenges to engaging in collaboration?
    - How open is the innovation process in the company?
    - The size of R&D personnel? R&D expenditures?
    - Challenges in cross-border innovation sourcing?

    Innovation sourcing – Identification

    - How does the company identify external knowledge sources?
    - How does the company approach these sources?
    - The role of social relations?

    Innovation sourcing – Transfer

    - What type of external innovation sourcing has the company engaged in? How long did this sourcing last (ad-hoc or continuous)?
    - What is the role of informal innovation sourcing? Conferences, trade exhibitions, 'stealing', 'spying', collaborations with competitors?
    - Why are certain sourcing mechanisms used more often than the others? What is the difference between contractual and non-contractual sourcing?

    Innovation sourcing – Absorption

    - Does the company engage in co-creation?
    - Does it train R&D personnel or employ trainees and graduates?
    - How does the company ensure that the sourced knowledge is linked to R&D in-house?

5. POLICY

- How do the current policy incentives suit external (cross-border) knowledge sourcing?
- What type of incentives would enhance the use of cross-border knowledge?

Appendix 4: Interviewees and workshop participants

Interviews:

Kari Komulainen (The Finnish Funding Agency for Technology and Innovation, Tekes), 30.06.2009 at VTT.

Petri Lehto (Ministry of Employment and the Economy), 25.08.2009 at the Ministry of Employment and the Economy

Harri Jokinen and Juhani Kangasniemi (The Federation of Finnish Technology Industries), 18.12.2010 at the Federation of Finnish Technology Industries

Workshop, 3rd March 2011 at VTT. 'SMEs and Internationalisation of Knowledge and Innovation Activities, the impact of internationalisation on Finnish SMEs and innovation systems'.

Invited commentators:

Antti Valle (Ministry of Employment and the Economy)

Lauri Seppälä (Planmed Oy)

Juha Ylä-Jääski (The Federation of Finnish Technology Industries)

Appendix 5: The source and type of knowledge sourced for innovation by SMEs

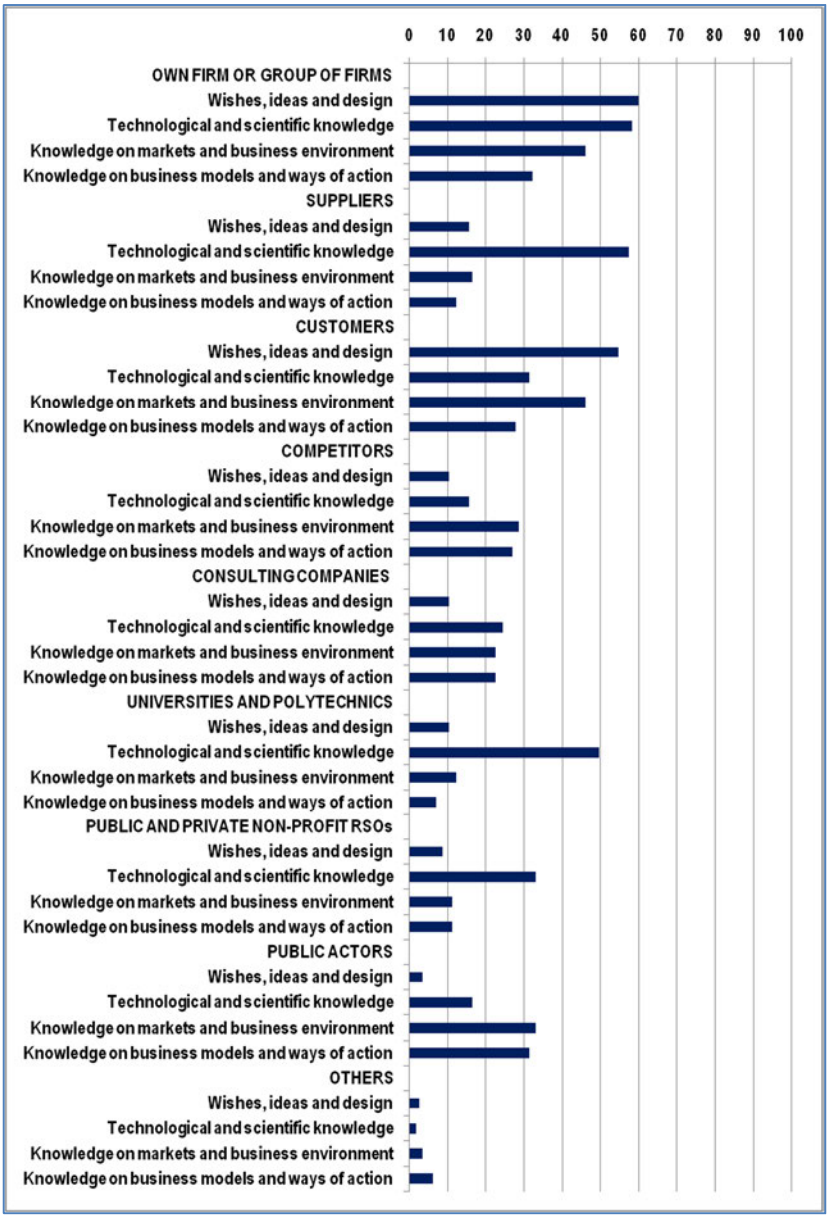

Figure 1. Domestic source and type of knowledge sourced for innovation by SMEs; % of respondent innovative SMEs in the target sectors (N = 115).

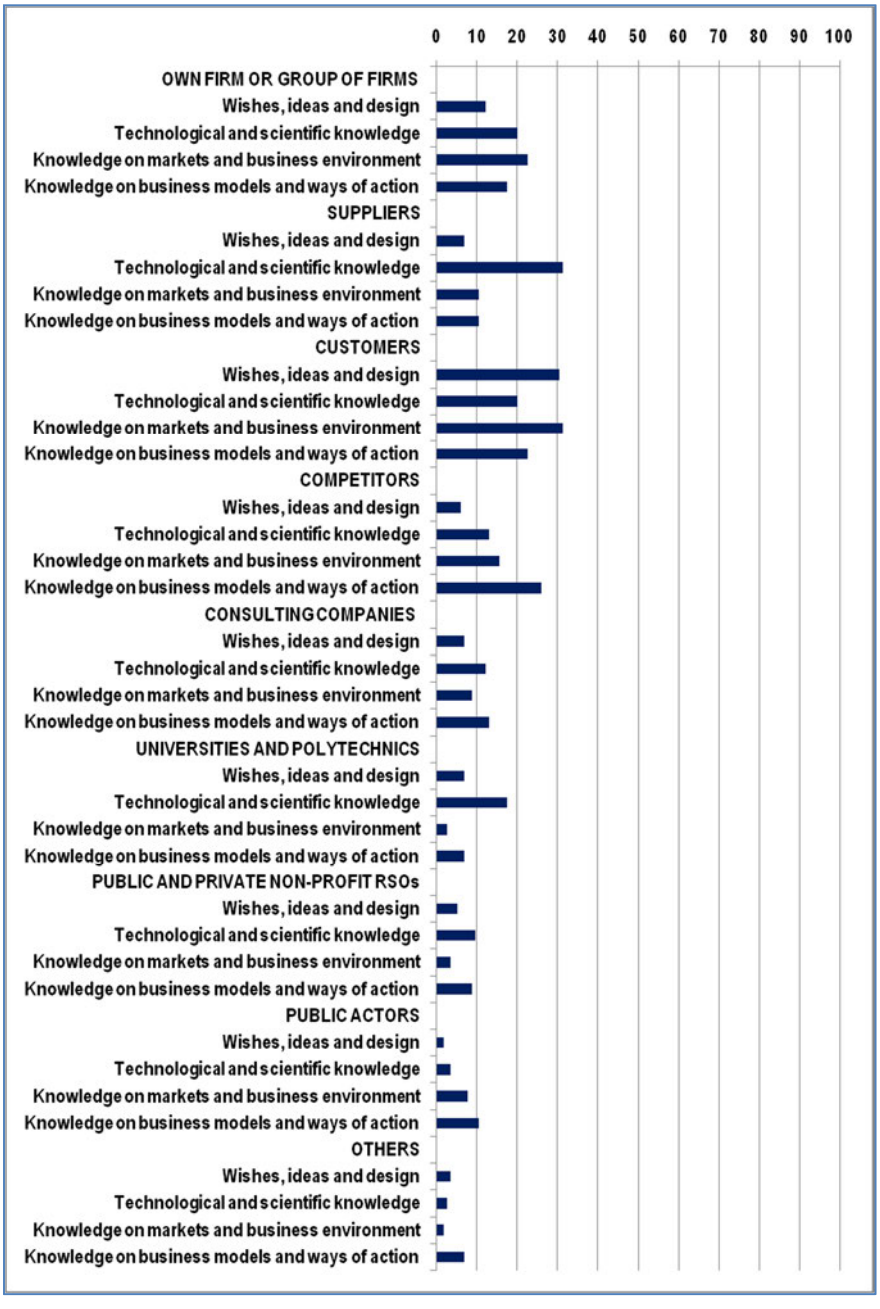

Figure 2. Foreign source and type of knowledge sourced for innovation by SMEs; % of respondent innovative SMEs in the target sectors (N = 115).

Appendix 6: Survey – correlation tables

INNOVATION CO-DEVELOPERS		LOG R&D	R&D INTENSITY	LOG TURNOVER	EUROPE	INTERNATIONAL	DOMESTIC CUSTOMERS	END-USERS	COMPETITORS	RESEARCH INSTITUTES	SUPPLIERS
	LOG R&D	1									
	R&D INTENSITY	**0,569**	1								
	LOG TURNOVER	-0,087	-0,136	1							
	EUROPE	-0,147	-0,095	0,018	1						
	INTERNATIONAL	0,113	0,031	0,161	**-0,236**	1					
DOMESTIC	CUSTOMERS	-0,103	-0,103	**0,201**	-0,039	0,057	1				
	END-USERS	0,102	0,099	0,033	-0,152	0,125	**0,312**	1			
	COMPETITORS	-0,092	-0,044	0,092	-0,174	0,003	**0,195**	0,053	1		
	RESEARCH	0,154	0,084	-0,118	0,062	0,015	0,069	0,160	0,128	1	
	SUPPLIERS	0,046	-0,001	0,040	-0,093	0,014	-0,001	**0,253**	**0,199**	0,044	1

INNOVATION CO-DEVELOPERS		LOG R&D	R&D INTENSITY	LOG TURNOVER	EUROPE	INTERNATIONAL	FOREIGN CUSTOMERS	END-USERS	COMPETITORS	RESEARCH INSTITUTES	SUPPLIERS
	LOG R&D	1									
	R&D INTENSITY	**0,569**	1								
	LOG TURNOVER	-0,087	-0,136	1							
	EUROPE	-0,147	-0,095	0,018	1						
	INTERNATIONAL	0,113	0,031	0,161	**-0,236**	1					
FOREIGN	CUSTOMERS	**0,247**	**0,232**	**0,205**	-0,089	-0,089	1				
	END-USERS	**0,240**	**0,214**	-0,124	**-0,222**	**-0,222**	**0,448**	1			
	COMPETITORS	0,092	0,122	**-0,228**	**-0,291**	**-0,291**	0,101	**0,418**	1		
	RESEARCH	**0,226**	**0,170**	-0,039	-0,043	-0,043	**0,273**	**0,430**	**0,296**	1	
	SUPPLIERS	**0,178**	0,098	-0,012	-0,174	-0,174	0,134	**0,305**	**0,318**	0,118	1

IMPORTANCE OF KNOWLEDGE SOURCES		LOG R&D	R&D INTENSITY	LOG TURNOVER	EUROPE	INTERNATIONAL	DOMESTIC OWN GROUP	SUPPLIERS	CUSTOMERS	COMPETITORS	CONSULTANTS	UNIVERSITIES	PUB RESEARCH	INTERMEDIAT	OTHERS
	LOG R&D	1													
	R&D INTENSITY	**0,569**	1												
	LOG TURNOVER	-0,087	-0,136	1											
	EUROPE	-0,147	-0,095	0,018	1										
	INTERNATIONAL	0,113	0,031	0,161	**-0,236**	1									
DOMESTIC	OWN GROUP	0,135	0,092	-0,012	0,088	0,084	1								
	SUPPLIERS	0,002	-0,112	-0,017	0,132	0,041	**0,237**	1							
	CUSTOMERS	0,054	-0,058	0,081	-0,063	-0,040	0,031	**0,369**	1						
	COMPETITORS	-0,049	-0,105	0,045	-0,063	-0,110	0,141	**0,279**	**0,487**	1					
	CONSULTANTS	-0,030	**-0,189**	-0,023	0,046	-0,144	0,049	**0,206**	**0,203**	**0,392**	1				
	UNIVERSITIES	0,122	-0,047	-0,111	0,002	-0,069	0,068	0,019	0,119	0,145	**0,460**	1			
	PUB RESEARCH	0,119	0,062	-0,097	0,132	-0,099	0,065	0,090	0,172	**0,208**	**0,474**	**0,576**	1		
	INTERMEDIAT	0,014	-0,057	-0,035	0,074	0,005	**0,221**	**0,296**	**0,220**	**0,219**	**0,465**	**0,335**	**0,285**	1	
	OTHERS	-0,121	-0,019	-0,023	0,032	0,043	0,016	-0,045	0,167	0,120	0,153	0,024	0,166	0,084	1

IMPORTANCE OF KNOWLEDGE SOURCES		LOG R&D	R&D INTENSITY	LOG TURNOVER	EUROPE	INTERNATIONAL	FOREIGN OWN GROUP	SUPPLIERS	CUSTOMERS	COMPETITORS	CONSULTANTS	UNIVERSITIES	PUB RESEARCH	INTERMEDIAT	OTHERS
	LOG R&D	1													
	R&D INTENSITY	**0,569**	1												
	LOG TURNOVER	-0,087	-0,136	1											
	EUROPE	-0,147	-0,095	0,018	1										
	INTERNATIONAL	0,113	0,031	0,161	**-0,236**	1									
FOREIGN	OWN GROUP	0,155	0,089	0,049	**-0,217**	**0,276**	1								
	SUPPLIERS	0,169	-0,040	-0,134	-0,040	0,021	**0,231**	1							
	CUSTOMERS	**0,195**	0,059	0,060	-0,114	**0,504**	**0,356**	**0,294**	1						
	COMPETITORS	0,001	0,066	-0,072	-0,096	0,090	**0,209**	**0,339**	**0,489**	1					
	CONSULTANTS	0,051	0,079	0,016	0,039	**0,204**	0,179	**0,243**	**0,351**	**0,477**	1				
	UNIVERSITIES	0,053	0,107	-0,062	0,030	0,035	**0,193**	0,129	**0,243**	**0,210**	**0,483**	1			
	PUB RESEARCH	0,030	**0,190**	-0,100	0,019	0,179	**0,214**	0,169	**0,326**	**0,267**	**0,540**	**0,799**	1		
	INTERMEDIAT	0,011	0,074	-0,092	0,026	0,090	**0,357**	**0,326**	**0,250**	**0,277**	**0,445**	**0,520**	**0,552**	1	
	OTHERS	0,049	0,186	-0,014	**0,200**	0,116	**0,252**	0,178	0,173	0,172	0,124	**0,317**	**0,435**	**0,369**	1

IMPORTANCE OF DIRECT CHANNELS DOMESTIC	OWN R&D	CONTRACT R&D	ACQUISIT OF EQUIPMENT	PURCHASE OF IPR	PURCHASE OF KNOWLEDGE	TRAINING	PUBLIC SERVICES	CO-DEVELOPM	STRATEGIC PARTNERSHIP	JOINT VENTURE	RECRUITMENT	EQUITY INVESTMENT	ACQUISIT OF R&D UNIT	INVESTOR'S PARTICIPATION	OTHER
OWN R&D	1														
CONTRACT R&D	-0,021	1													
ACQUISITION OF EQUIPMENT	**0,196**	**0,203**	1												
PURCHASE OF IPR	0,036	**0,336**	**0,232**	1											
PURCHASE OF KNOWLEDGE	0,015	**0,442**	**0,194**	**0,256**	1										
TRAINING	**0,232**	0,137	**0,195**	**0,202**	**0,216**	1									
PUBLIC SERVICES	-0,007	**0,380**	**0,363**	**0,422**	**0,557**	**0,398**	1								
CO-DEVELOPMENT	0,080	**0,339**	0,135	**0,185**	**0,271**	**0,267**	**0,347**	1							
STRATEGIC PARTNERSHIP	0,032	**0,198**	0,159	0,078	**0,275**	0,176	**0,193**	**0,368**	1						
JOINT VENTURE	-0,013	**0,247**	0,143	**0,455**	0,172	**0,239**	**0,306**	**0,299**	**0,245**	1					
RECRUITMENT	0,153	**0,230**	**0,230**	0,295	**0,300**	**0,219**	**0,244**	0,143	**0,182**	**0,422**	1				
EQUITY INVESTMENT	0,155	0,172	**0,218**	**0,237**	**0,246**	0,177	**0,345**	**0,250**	0,164	**0,476**	**0,302**	1			
ACQUISTION OF R&D UNIT	0,012	0,143	0,148	**0,331**	0,171	**0,215**	**0,261**	**0,234**	**0,248**	**0,720**	**0,327**	**0,541**	1		
INVESTOR'S PARTICIPATION	0,100	0,074	0,133	0,037	0,168	0,096	**0,222**	0,037	-0,007	**0,229**	**0,236**	**0,310**	**0,282**	1	
OTHER	-0,089	0,046	0,041	**0,194**	0,113	0,055	0,092	0,067	0,042	**0,418**	0,146	**0,398**	**0,621**	**0,202**	1

IMPORTANCE OF DIRECT CHANNELS FOREIGN	OWN R&D	CONTRACT R&D	ACQUISIT OF EQUIPMENT	PURCHASE OF IPR	PURCHASE OF KNOWLEDGE	TRAINING	PUBLIC SERVICES	CO-DEVELOPM	STRATEGIC PARTNERSHIP	JOINT VENTURE	RECRUITMENT	EQUITY INVESTMENT	ACQUISIT OF R&D UNIT	INVESTOR'S PARTICIPATION	OTHER
OWN R&D	1														
CONTRACT R&D	**0,278**	1													
ACQUISITION OF EQUIPMENT	**0,281**	**0,337**	1												
PURCHASE OF IPR	0,174	0,139	**0,251**	1											
PURCHASE OF KNOWLEDGE	0,165	**0,326**	**0,323**	**0,346**	1										
TRAINING	**0,287**	**0,467**	**0,363**	**0,371**	**0,315**	1									
PUBLIC SERVICES	**0,213**	**0,387**	**0,385**	**0,390**	**0,238**	**0,823**	1								
CO-DEVELOPMENT	0,156	**0,449**	**0,356**	**0,198**	**0,239**	**0,405**	**0,417**	1							
STRATEGIC PARTNERSHIP	**0,220**	**0,368**	**0,287**	-0,072	**0,210**	**0,288**	**0,186**	**0,280**	1						
JOINT VENTURE	**0,234**	**0,408**	0,113	0,175	0,156	**0,376**	**0,222**	0,053	**0,213**	1					
RECRUITMENT	0,058	**0,427**	**0,374**	0,125	**0,353**	**0,610**	**0,651**	**0,279**	**0,306**	**0,352**	1				
EQUITY INVESTMENT	0,032	**0,312**	0,158	0,180	0,076	**0,260**	**0,409**	0,108	0,031	0,159	**0,281**	1			
ACQUISTION OF R&D UNIT	0,032	**0,312**	0,158	0,180	0,076	**0,260**	**0,409**	0,108	0,031	0,159	**0,281**	**1,000**	1		
INVESTOR'S PARTICIPATION	**0,213**	**0,455**	**0,192**	0,116	0,136	**0,464**	**0,298**	0,082	**0,264**	**0,556**	**0,636**	**0,177**	0,177	1	
OTHER	0,022	0,135	0,016	0,127	0,054	0,110	0,129	0,076	0,022	**0,245**	**0,198**	**0,704**	**0,704**	**0,266**	1

IMPORTANCE OF INDIRECT CHANNELS DOMESTIC	NETWORKS	EXTERNAL INFORM.	RESEARCH PROGRAM.	OTHER PROGRAM.	CONFERENCES FAIRS	INDUSTRIAL FEDERATIONS	SCIENTIFIC JOURNALS	OTHER
COLLABORATION NETWORKS	1							
EXTERNAL INFORMANTS	**0,277**	1						
RESEARCH PROGRAMMES	0,072	**0,257**	1					
SHOKS & OTHER PROGRAM.	**0,198**	**0,372**	**0,445**	1				
CONFERENCES, FAIRS	**0,330**	**0,214**	0,178	**0,317**	1			
INDUSTRIAL FEDERATIONS	**0,243**	**0,308**	0,176	**0,402**	**0,401**	1		
SCIENTIFIC JOURNALS	**0,263**	0,094	0,140	**0,351**	**0,496**	**0,280**	1	
OTHER	0,162	0,082	0,063	0,171	-0,011	**0,189**	**0,243**	1

IMPORTANCE OF INDIRECT CHANNELS FOREIGN	NETWORKS	EXTERNAL INFORM.	RESEARCH PROGRAM.	OTHER PROGRAM.	CONFERENCES FAIRS	INDUSTRIAL FEDERATIONS	SCIENTIFIC JOURNALS	OTHER
COLLABORATION NETWORKS	1							
EXTERNAL INFORMANTS	**0,389**	1						
RESEARCH PROGRAMMES	**0,429**	**0,396**	1					
SHOKS & OTHER PROGRAM.	**0,390**	**0,499**	**0,497**	1				
CONFERENCES, FAIRS	**0,371**	**0,234**	**0,285**	**0,256**	1			
INDUSTRIAL FEDERATIONS	**0,285**	**0,373**	**0,312**	**0,430**	**0,350**	1		
SCIENTIFIC JOURNALS	**0,373**	**0,319**	**0,291**	**0,285**	**0,613**	**0,275**	1	
OTHER	**0,258**	**0,266**	**0,349**	**0,372**	0,028	0,107	**0,215**	1

MOTIVES	NO DOMEST. KNOWLEDGE	R&D FOREFRONT	NEW PROD. SERVICES	NEW MARK. USER NEEDS	INCR. MARKET SHARE	TECHNOLOGY TRANSFER	CLOSER TO CUSTOMERS	CAPACITY SOURCING	EXTENDING TO NEW SECTOR	FOCUSING ON CORE BUSINESS	RECUSING R&D COSTS	FOLLOWING CUSTOMERS	OTHER
NO DOMESTIC KNOWLEDGE	1												
STAYING IN R&D FOREFRONT	**0,554**	1											
NEW PRODUCTS, SERVICES	**0,430**	**0,669**	1										
NEW MARKETS, USER NEEDS	**0,345**	**0,558**	**0,666**	1									
INCREASING MARKET SHARE	**0,198**	**0,356**	**0,405**	**0,719**	1								
TECHNOLOGY TRANSFER	**0,596**	**0,631**	**0,558**	**0,484**	**0,379**	1							
CLOSER TO CUSTOMERS	**0,221**	0,121	**0,186**	**0,323**	**0,338**	**0,345**	1						
CAPACiTY SOURCING	**0,188**	0,165	0,149	**0,341**	**0,497**	**0,300**	**0,418**	1					
EXTENDING TO NEW SECTOR	0,167	**0,287**	**0,320**	**0,399**	**0,303**	**0,316**	**0,308**	**0,381**	1				
FOCUSING ON CORE BUSIN.	**0,284**	**0,243**	**0,257**	**0,448**	**0,466**	**0,421**	**0,451**	**0,485**	**0,324**	1			
REDUCING R&D COSTS	**0,328**	**0,289**	**0,198**	**0,367**	**0,317**	**0,386**	**0,419**	**0,415**	**0,374**	**0,631**	1		
FOLLOWING CUSTOMERS	**0,277**	**0,262**	**0,277**	**0,329**	**0,331**	**0,296**	**0,381**	**0,337**	**0,321**	**0,461**	**0,526**	1	
OTHER	0,152	0,063	0,123	0,101	0,091	-0,040	0,023	0,210	0,201	-0,088	-0,095	-0,020	1

BARRIERS	NO SOLUTION PROVIDED	LEAKING COMPETENCY	LEAKING TECHNOLOGY	CONSTRAINTS REGULAT.	DIFFIC. TO FIND A PARTNER	TACIT KNOWLEDGE	NOVEL RESEARCH	DIFFIC. TO MATCH R&D	LANGUAGE CULTURE	OTHER
NO SOLUTION PROVIDED	1									
LEAKING CORE COMPETENCY	**0,528**	1								
LEAKING CORE TECHNOLOGY	**0,563**	**0,795**	1							
CONSTRAINTS, REGULATIONS	**0,385**	**0,438**	**0,471**	1						
DIFFICULT TO FIND A PARTNER	**0,347**	**0,452**	**0,461**	**0,424**	1					
TACIT KNOWLEDGE	**0,450**	**0,557**	**0,541**	**0,339**	**0,489**	1				
NOVEL RESEARCH	**0,278**	**0,392**	**0,237**	**0,200**	**0,424**	**0,400**	1			
DIFFICULT TO MATCH R&D	**0,391**	**0,396**	**0,393**	**0,378**	**0,306**	**0,333**	**0,356**	1		
LANGUAGE, CULTURE	**0,208**	**0,270**	**0,299**	**0,387**	**0,491**	**0,387**	**0,208**	**0,316**	1	
OTHER	0,057	-0,040	0,006	0,160	0,050	0,060	0,065	**0,217**	0,164	1

OBJECTIVES	STARTING EXPORT	ESTABL./ACQ. FRGN UNIT	ESTABL./ACQ. JOINT VENT.	ESTABL. STRAT. ALL.	OUTSOURCING TO OWN AFFILIT.	OUTSOURCING TO OTHERS	COMPANY CO-OPERATION	UNIVERSITY CO-OPERATION	ESTABL./ACQ. R&D UNIT	OUTSOURC. R&D TO OWN AFFIL.	OUTSOURC. R&D TO OTHERS	EXTENDING R&D SOURCING	NEW SOURC. MECHANISMS	OTHER
STARTING EXPORT	1													
ESTABL./ACQUIR. UNIT	**0,453**	1												
ESTABL. JOINT VENTURE	**0,400**	**0,627**	1											
ESTABL. STRATEG. ALLIANCE	**0,357**	**0,535**	**0,565**	1										
OUTSOURCING TO OWN AFF.	**0,275**	**0,540**	**0,472**	**0,356**	1									
OUTSOURCING TO OTHERS	**0,284**	**0,492**	**0,532**	**0,488**	**0,469**	1								
COMPANY CO-OPERATION	**0,367**	**0,474**	**0,533**	**0,783**	**0,328**	**0,514**	1							
UNIVERSITY CO-OPERATION	0,081	**0,265**	**0,225**	**0,386**	**0,257**	**0,245**	**0,265**	1						
ESTABL./ACQUIR. R&D UNIT	0,124	**0,425**	**0,259**	**0,188**	**0,368**	**0,304**	0,142	**0,471**	1					
OUTSOURC. R&D TO OWN AFF.	**0,235**	**0,526**	**0,402**	**0,228**	**0,524**	**0,256**	0,120	**0,306**	**0,483**	1				
OUTSOURC. R&D TO OTHERS	**0,264**	**0,358**	**0,373**	**0,340**	**0,308**	**0,516**	**0,394**	**0,285**	**0,353**	**0,359**	1			
EXTENDING R&D SOURCING	0,069	**0,279**	**0,272**	**0,330**	**0,228**	**0,269**	**0,296**	**0,499**	**0,329**	**0,295**	**0,451**	1		
NEW SOURC. MECHANISMS	**0,254**	**0,219**	**0,239**	**0,399**	**0,226**	**0,286**	**0,362**	**0,332**	**0,303**	**0,269**	**0,302**	**0,527**	1	
OTHER	0,059	0,045	0,041	0,085	0,167	0,018	0,028	0,152	**0,198**	0,181	0,143	0,166	0,069	1

Appendix 7: Knowledge transfer mechanisms by type

DIRECT INNOVATION KNOWLEDGE TRANSFER MECHANISMS BY DURATION

Short-term	***Mid-term***	***Long-term***
Contract R&D	Training (own or ordered)	Joint venture
Acquisition of equipment, materials, components or software	Co-development and knowledge exchange (project based, including cooperation with research organisations)	Recruitment of R&D personnel
Purchase of IPRs	Strategic partnerships and long-term cooperation with other companies	Equity investments in other companies
Purchase of other knowledge (information), such as market surveys and technological information		Acquisition of R&D units or companies
Public services (e.g., ELY centre or foreign equivalent)		External investors' participation in executive committee

IN-DIRECT INNOVATION KNOWLEDGE TRANSFER MECHANISMS BY ACTIVITY

Public	***Communities***	***Conferences***
Special public programs (e.g., centre of excellence or foreign equivalent)	Participation in collaboration networks (e.g., social networks)	Conferences, trade shows and exhibitions
External informant (e.g., trade promoter and innovation promoter)	Industry federations and chambers of commerce	Scientific journals and trade journals

Appendix 8: Key actors in supporting internationalisation

The objective of the ministries is to design and implement policies in their respective fields. In the business sector, the main actor is the Ministry of Employment and the Economy, which bears the overall responsibility for business environment policy. As part of the policy, the ministry is also responsible for promoting exports and the internationalisation of enterprises. In a small country like Finland, rapid economic growth can only be achieved by utilising the global market (i.e., by exporting and going global) (www.tem.fi).

Similarly, the Foreign Service of the Ministry for Foreign Affairs promotes companies' exports and internationalisation and Finland's economic interests abroad. On account of the intensifying competition in the international markets, networking and cooperation have become increasingly important instruments and a key challenge for Finnish companies (http://formin.finland.fi). The Ministry of Education and Culture plays a less direct but equally important role in the internationalisation of innovation activities. Through its policies, the ministry can affect the pool of skilled labour in Finland.

The ministries coordinate the centres and associations under their governance. In the Ministry of Employment and the Economy, the supporting services for internationalisation are provided by Tekes – the Finnish Funding Agency for Technology and Innovation, Finpro, Invest in Finland and the VTT Technical Research Centre of Finland. They can be used to promote national and international networking among the actors of the innovation environment, such as the poles and clusters of excellence. They help to develop an environment that supports R&D cooperation and innovation through the use of the ministry's official contacts and cooperation in international technology.

Financial services are provided by the regional Centres for Economic Development, Transport and the Environment (i.e., ELY Centres [formerly the Centres for Employment and Economic Development: TE Centres]), Tekes, Finnvera Plc and Finnish Industry Investment Ltd. Assistance, development services and/or training are provided by the Centre for Economic Development, Transport and the Environment, the Finnish Tourist Board, the International FinNode Innovation Centres, different Chambers of Commerce (e.g., Swedish and Russian), the International Chamber of Commerce Viexpo, Design Forum Finland and Music Export Finland.

Tekes' role is to support applied research and development. Tekes' technology programmes offer not only a framework for cooperation between academia and enterprises – as well as among enterprises − but also for joint R&D projects at an international level. In addition, Tekes provides assistance in creating strategic centres for science, technology and innovation and spurs them in developing their activities. To promote internationalisation, Tekes offers preparatory funding, the GAP (Global Access Programme), EU funding opportunities and researcher exchange funding.

Finpro is a global organisation that helps build the growth and success of Finnish companies in the international markets (www.finpro.fi). Finnvera is a specialised financing company owned by the State of Finland that provides its clients with loans, guarantees, venture capital investments and export credit guarantees. It provides financing for the start, growth and internationalisation of SMEs (www.finnvera.fi). Finnish Industry Investment Ltd is a government-owned investment company whose mission is to promote Finnish business, job creation and economic growth through venture capital and private equity investments. Finnish Industry Investment invests in funds and directly invests in growth companies in all sectors. The investment focus is on growth, internationalisation, spin-offs, major industrial investments, and sectorial and corporate restructurings. Finnish Industry Investment invests together with private co-investors and limits its investment to at most one-half of the invested capital and ownership (http://www.teollisuussijoitus.fi).

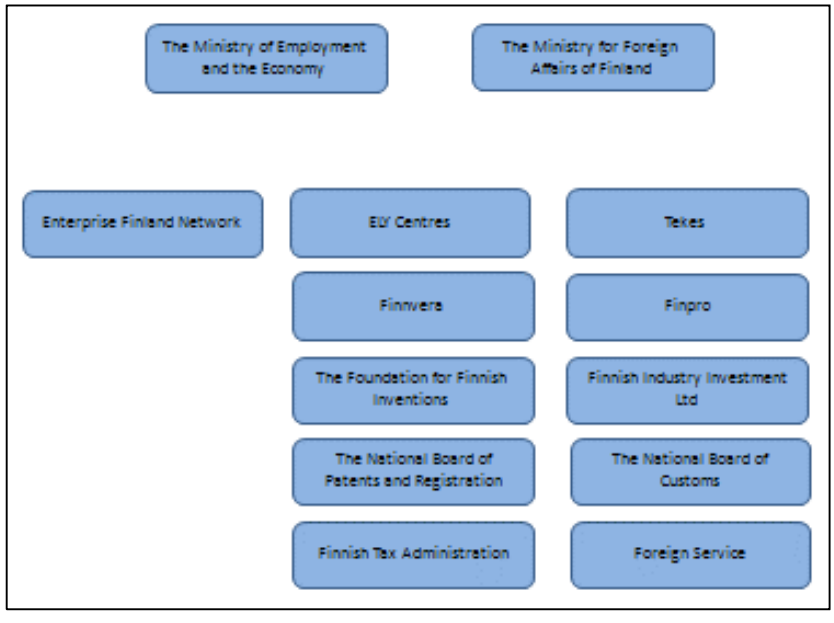

Figure 1. Key actors that belong to the Enterprise Finland Network to support companies in internationalisation.

In addition to various organisations, Finland has created and is part of international virtual networks aimed at advancing Finnish firms' international activities on several levels. One of these networks is Enterprise Finland, which is an online service that is available to its users free of charge. It provides information about the types of assistance available to companies or entrepreneurs for establishing and developing their businesses. In particular, Enterprise Finland targets SMEs. The service contains offerings from the nine organisations active in promoting

innovation: ELY Centres, Tekes, Finnvera, Finpro, the Foundation for Finnish Inventions, Finnish Industry Investment, the National Board of Patents and Registration, the National Board of Customs, the Finnish Tax Administration, and the Foreign Service of the Ministry for Foreign Affairs. Enterprise Finland is coordinated by the Ministry of Employment and the Economy (www.yrityssuomi.fi).

In contrast, the European-level network (Enterprise Europe Network) provides services related to internationalisation and technology transfer for SMEs, universities and research institutes. The European Commission launched the network in 2008 as part of the Competitiveness and Innovation Framework Programme (CIP). It builds on the former Euro Info Centre (EIC) and Innovation Relay Centre (IRC) networks, which were established in 1987 and 1995, respectively.

The Enterprise Europe Network provides a wide range of services, including disseminating information on EU-related issues and searching for international partners. Information on EU legislation and directives, various EU funding options and internal market activities is also available through the Network. The Network offers support to those searching for commercial or technological cooperation partners by supplying contact information and organising business contact events via large-scale international conventions. The Enterprise Europe Network has operations not only in each EU member state but also outside of the EU and operates in a total of 48 countries. The Network includes nearly 600 organisations and employs more than 3,000 specialists (www.tem.fi).

The Finnish Enterprise Europe Network is coordinated by the Ministry of Employment and the Economy. The Finnish Consortium of the Enterprise Europe Network has eight partner organisations. Commercial services and services related to financing, legal issues and corporate contacts are provided by the ELY Centre for Southwest Finland, the Helsinki Region Chamber of Commerce. Technology transfer and cooperation services related to global technology transfers, the search for cooperation partners or R&D cooperation are provided by the Finnish Science Park Association (TEKEL), Technopolis Ltd, Licentia Ltd, Turku Science Park Ltd and Hermia Business Development Ltd (www.tem.fi).

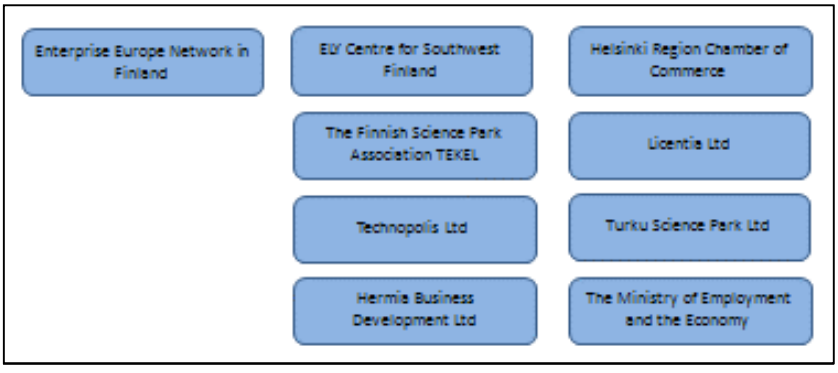

Figure 2. Key actors supporting companies in internationalisation and included in the Enterprise Europe Network in Finland.

At the global level, Finland has established a network of Finnish innovation organisations, the FinNode Innovation Centres. Operating via nodes in global innovation activities, FinNode actively reveals new openings for Finnish business and research organisations and supports their internationalisation. It connects Finnish and international experts and the know-how required to promote innovation. As FinNode represents all sections of the Finnish innovation system in the countries where it operates, foreign partners can interact with Finland's central public innovation organisations. The FinNode network currently operates in the United States, China, Russia, Japan and India.

The central Finnish actors in FinNode's international network consist of the Ministry of Employment and the Economy, the Ministry for Foreign Affairs, Finpro, Tekes, Sitra (the Finnish Innovation Fund), the VTT Technical Research Centre of Finland and the Academy of Finland. The Ministry of Education and Culture and the Confederation of Finnish Industries (EK) also help to direct FinNode's activities. Finpro is responsible for managing the FinNode network.

The network's principal interest groups in Finland are the Centres of Expertise (OSKEs), the Strategic Centres for Science, Technology and Innovation (SHOKs), and the ELY Centres. The FinNode network offers participants an umbrella organisation under which common objectives can be promoted (www.finnode.fi).

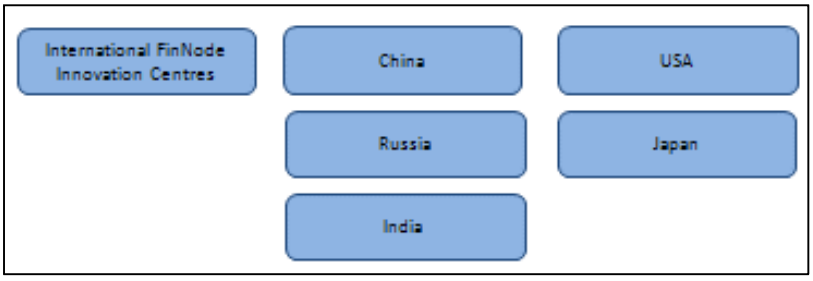

Figure 3. Countries included in the international FinNode Innovation Centres.

Tekes's global operations are part of the FinNode Innovation Centre network that boosts international R&D cooperation and business. FinNode provides a gateway for international enterprises wishing to hook up with partners in Finland, regardless of whether they are looking for business contacts, cutting-edge research, or R&D resources. Tekes is also the nodal point of many European research activities in Finland, such as the EUREKA network, the EU 7th Research Framework Programme, COST and the European Space Agency (ESA). The Tekes office in Brussels fosters collaborations between Finland and the European R&D programmes. In the Global Access Programme (GAP), Finnish firms sponsored by Tekes can engage world-class technology and technological know-how together with MBA students from the University of California, Los Angeles (UCLA).

In 2008, Tekes launched funding for young innovative companies (NIY instrument) aiming to achieve fast international growth. The objective of the first funding phase is to get the company on a growth path and to demonstrate the company's competitiveness in the international market. In addition to funding young, innovative growth companies, Tekes aims to promote the development of potential growth companies through the Vigo Accelerator programme, which was launched together with the Ministry of Employment and the Economy. The aim of the programme is to create new growth companies and success stories (www.tekes.fi/about/niy). In 2011, Tekes launched a new financing program called Tempo to support growth companies developing mobile services and applications.

In 2006, the Finnish Science and Technology Policy Council (since 2009, Research and Innovation Council, RIC), which coordinates the public funding for research and development in Finland, decided to launch the Strategic Centres for Science, Technology, and Innovation (SHOK)[36]. They provide a new opportunity for long-term cooperation for top-level research institutes and companies making use of the research results. The centres are responsible for implementing a long-

[36] The six focus areas of SHOKs: Forest cluster: Forestcluster Ltd, Information and communication industry and services: TIVIT Ltd, Metal products and mechanical engineering: FIMECC Ltd, Energy and the environment: CLEEN Ltd, Built environment innovations: RYM Ltd, Health and well-being cluster: SalWe Ltd.

term research plan drawn up jointly by businesses and research institutes. Together with the Competence Clusters carried out by regional Centres of Expertise (OSKE), they create an improved scope for the creation of globally competitive and attractive innovation environments in Finland.

The EUREKA Initiative is a decentralised network that brings together 38 European member states and the European Union with the aim of fostering cooperation in research and innovation. Finland was one of the member states responsible for establishing the EUREKA Initiative in 1985. EUREKA is a pan-European network for market-oriented and industry-related R&D. It promotes the competitiveness of European companies by creating links and networks of innovation. Tekes is the coordinator of EUREKA activities in Finland (http://www.tekes.fi/en/community/European_cooperation).

Established in 1971, the European Cooperation in Scientific and Technical Research (COST) has developed into one of the largest frameworks for networking collaboration in European research. The national COST offices and COST National Coordinators (CNC) in each member country disseminate information on COST activities and procedures. Finland has been highly active in taking advantage of international networking opportunities and participates in two-thirds of the almost 200 current COST activities. Tekes coordinates the COST activities in Finland (http://www.tekes.fi/en/community/European_cooperation).

The Eurostars Programme is the first European funding and support programme to be specifically dedicated to SMEs. Eurostars will stimulate them to lead international collaborative research and innovation projects by easing access to support and funding. It can address any technological area, but the technology must have a civilian purpose and be aimed at the development of a new product, process or service. A Eurostars project is collaborative, which means that it must involve at least two participants (legal entities) from two different countries participating in Eurostars. In addition, the main participant must be a research-performing SME from one of the member countries (www.eurostars-eureka.eu).

The Seventh Framework Programme for research and technological development (FP7) promotes and encourages the creation of European poles of scientific excellence. It is the European Union's chief instrument for funding research over the period 2007–2013. Tekes hosts the Finnish Secretariat for EU R&D, which provides information on FP7 and coordinates the Finnish National Contact Point System.

The FP7 contains numerous opportunities open to innovative SMEs, although the collaborative research projects (with partners from more than 3 countries) are highly competitive, slowly progressing and long lasting. Approximately 20% of the applications will be funded. The approved projects are often strategic and demanding R&D projects. One positive outcome is that they will entail international networks.

Research for SMEs and Research for SME Associations are two initiatives dedicated to strengthening the innovative capacities of SMEs by providing the support they need to outsource research critical to their core businesses. The European Commission provides 75% of the funding to the SMEs' R&D projects. Funding is also available for purchasing R&D services.

Finally, there are some consulting services on growth and internationalisation. In the Oulu region, the development and marketing company Micropolis Ii Ltd spurs the growth and internationalisation of the energy and environmental business sector. The services extend throughout Finland in collaboration with companies and research institutes. Fintra, a training organisation owned by the Finnish government, helps Finnish companies to meet the growing challenges in global business. Fintra has specialised in providing training services for Finnish companies that are either starting global businesses or already active in this field (www.fintra.fi).

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Title	**Internationalisation of knowledge and innovation activities in Finnish innovative SMEs**
Author(s)	Olavi Lehtoranta, Nina Rilla & Torsti Loikkanen
Abstract	This publication presents the results of a research project on the internationalisation of innovation activities in Finnish SMEs. We claim that understanding of the internationalisation of SMEs' knowledge and innovation (K&I) activities is a complex task requiring a holistic and interdisciplinary approach. Therefore the study consists of three main blocks of research: statistical micro data analysis, sector surveys and a qualitative case study. The study concentrates on five industry sectors: biotechnology, medical devices, metal products, consumer electronics and technical services. A major premise of this study is that companies rely increasingly on knowledge created outside of them (external knowledge). The growth and competitiveness of companies largely depend on their ability to take advantage of the international arena for innovation. Thus, the ability to absorb, reconfigure and exploit relevant knowledge is increasingly recognised as a key to a company's overall business strategies, especially to its knowledge and innovation activities. Even large multinationals recognise that they cannot rely on their in-house research and innovation capabilities. The pilot survey reveals that approximately 40% of innovative SMEs have co-developed innovations together with their foreign partner. Taken as a whole, 60% of SMEs stated that they had collaborated in some manner for innovation with a foreign partner. Foreign suppliers and affiliates are the most important cross-border knowledge sources for the SMEs under consideration. With respect to foreign knowledge sourcing channels, strategic partnerships, public services, project-based knowledge exchanges and purchases of market surveys and technological information are also seen as important. The Community Innovation Survey (CIS) data suggests that collaboration within the value chain (vertical) and with competitors (horizontal) increases the companies' ability to bring new products to the market, as well as the companies' economic returns to innovation (the share of turnover from products new to the market). Furthermore, we found that SMEs' innovation capabilities increase with the overall (previous) inflow of employees from MNEs. Innovation capabilities increase the companies' overall attitudes towards innovation activities (selection equation) and the companies' capability to commercialise products new to the market (outcome equation). The inflow of employees from national groups does not, however, have an effect.
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Internationalisation of knowledge and innovation activities in Finnish innovative SMEs

This publication presents the results of a research project on the internationalisation of innovation activities in Finnish SMEs. We claim that understanding of the internationalisation of SMEs' knowledge and innovation (K&I) activities is a complex task requiring a holistic and interdisciplinary approach. Therefore the study consists of three main blocks of research: statistical micro data analysis, sector surveys and a qualitative case study. The study concentrates on five industry sectors: biotechnology, medical devices, metal products, consumer electronics and technical services.

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