

Nordic SMEs and Regional Innovation Systems

Final Report

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Preface

This document constitutes the final report of the research project '*Nordic SMEs and Regional Innovation Systems*'. During 2002-2003 the project has been funded by the Nordic Industrial Fund, Center for Innovation and Commercial Development, an institution under the Nordic Council of Ministers. Its main aim is to strengthen the Nordic business sector through the creation of a Nordic knowledge market. It does this by initiating and financing projects and activities that create synergy between the actors in the Nordic innovation system. This report provides a Nordic comparative case analysis on SMEs, regional innovation systems, clusters and innovation policy based on joint research between various universities and research institutes in the Nordic countries. Bjørn Terje Asheim has been the project leader coordinating the various partners. This report has been written and compiled by Bjørn Terje Asheim, Lars Coenen and Martin Svensson-Henning from the materials and inputs provided by the researchers in the project. We gratefully acknowledge the support provided by the Nordic Industrial Fund.

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Executive Summary

SMEs, innovations and innovation systems: a broad perspective

Findings

- The ability to innovate is key for the competitiveness of Nordic SMEs in a globalizing economy. Especially because of the high wage level, innovation provides a more promising strategy than competition aimed at achieving the lowest costs. Understood in a broad context, innovativeness is not restricted to high-tech industries alone but can also be achieved by traditional low-tech sectors.
- Due to their small size, SMEs often innovate through interaction with other firms and universities and research institutes (i.e. systems of innovation). SMEs collaborate with systems of innovation on regional, national or even international levels, dependant on their knowledge and competence needs.
- SMEs that innovate through science-driven R&D (e.g. in biotech) tend to collaborate with partners across the world in search for new and unique knowledge.
- SMEs that innovate through engineering based user-producer learning tend to collaborate with nearby partner. Here, innovation often involves the application of existing knowledge or new combinations of knowledge.

Policy recommendations

- Policy measures to boost the competitive strength of SMEs have to primarily target their innovative performance.
- A broad based innovation policy aims at the general learning ability of SMEs, i.e. technological and organizational learning. It goes beyond and integrates traditional domains of industrial and economic policy, research and technology policy, education policy and regional development policy.
- In core regions, regional systemic innovation support for SMEs entails establishing closer linkages between SMEs and regional universities and research institutes. In peripheral regions, this often needs to be complemented by upgrading the capacities of the regional knowledge institutes. This is especially valid for engineering based innovation practices.
- Policy measures that help SMEs to access innovation support at a wider national or international also need to be developed, especially for science based innovation practices.

SMEs, clusters and cluster life-cycles

Findings

- Collaboration between SMEs in a cluster raises their innovative performance and competitiveness by combining resources and processes of interactive learning. Through vertical collaboration firms co-operate with suppliers and customers throughout the value chain. Through horizontal collaboration firms develop co-operative arrangements with competitors. One of the most important features of clustered firms is the ability to combine competition and collaboration
- Large firms can play very different roles for clustered SMEs. For example, they can be important and demanding customers. This puts them into an ambivalent position towards the supplying SMEs. On the one hand they can push the innovative performance of the SMEs by requiring high quality standards. But they can also destabilize co-operation structures in the cluster. Additionally they can function as a spring-board for new firms through spin-off formation.
- Clusters tend to witness different stages in their life cycle showing different characteristics in terms of collaboration networks, technology upgrading and demands of skilled labor and venture capital. This research has made a distinction between:
 - o Embryonic clusters: in a very early stage of development;
 - o Stagnant clusters: mature or even declining clusters;
 - o Rejuvenated clusters: having seen periods of threatening decline, but proven able to renew them selves.

Policy recommendations

- Change firm behavior towards appreciating the advantages made possible through more intense vertical and horizontal collaboration.
- The cluster concept has become quite fashionable among policy makers. Good policy practice needs to take account of the development stage a cluster is involved in.
- Embryonic clusters are especially in need of inter-firm collaboration initiatives and linkages with universities and research institutes. Because of its dependence on highly skilled labour it needs an up-to-date education structure.
- Stagnant clusters mainly need support to revitalize old structures and bring in new technology and knowledge. Thus, policy measures should stimulate entrepreneurship and new firm start-up. Also education policy provides an opportunity to rejuvenate a stagnant cluster by upgrading the knowledge base.

Social capital and trust: cornerstones for regional collaboration in innovation

Findings

- Understanding innovation as interactive learning implies that cooperation is necessary for the competitiveness of SMEs. Therefore, social capital is one of the prerequisites of a working cluster or regional innovation system. It is defined as features of social organization, such as networks, norms, and trust, that facilitate action and cooperation for mutual benefit.
- In a Nordic cluster context, especially initiatives on social networking arrangements have been particularly successful to boost and secure social capital and trust. Examples of such social networking initiatives are the Professional Forum for Food and Drink in the Rogaland food cluster or the Skive carpenter's guild in the Salling furniture cluster.
- A prerequisite however is that SMEs recognize the added value in taking part in such arrangements in order to invest time, effort and financial resources. Yet, the dynamics in network participation seem to be of a cumulative kind: the more firms become members, the more want to join.

Policy recommendations

- The role of trust and social capital in a cluster context is till relatively weakly understood. Therefore more research is needed in this field.
- Policy support may be needed to stimulate network membership. SMEs tend to have little management resources and may thus undervalue participation. This involves a conflict between individual short term firm interest and the collective long-term interest. Furthermore, the benefits of membership are difficult to measure in quantitative terms and may be difficult to grasp for SME managers.
- Another way of building social capital is through participatory, bottom-up policy making. Through collaboration between SMEs, large firms, universities, research centres and public policy-makers in jointly designing regional development and innovation strategies, trust between the partners can be enhanced, both inside and outside the policy arena. In addition, such policy initiatives are very demand driven as they are sensitive to the actual needs of the actors in the region.

SMEs and the regional knowledge infrastructure

Findings

- Research collaboration between SMEs and regional R&D institutes and universities is still a relatively new phenomenon in the Nordic countries and certainly no cure-all to increase firm innovativeness. The partners are often involved in an ongoing effort to learn to actually co-operate. Furthermore it is critical to consider the partners' knowledge base: successful cooperation in innovation requires a fine-tuned and difficult to achieve match between academic knowledge and the concrete practice of SMEs. Most opportunities in this field seem to lie in science based university-firm linkages.
- Especially in high-tech industries, an efficient vehicle for capitalizing on academic knowledge is through spin-offs from university. This creates directly innovative, knowledge-intensive SMEs. However, researchers often lack the managerial skills needed to successfully run a business.
- SMEs are highly dependant on the skill level of their workforce for their innovative capacity, especially in a collaboration context. In general, regional supply of skilled labor is probably the most important innovation support that universities can provide to SMEs.

Policy recommendations

- Given the small resource base of SMEs policy makers can help firms to find the right partner or contact within the university or R&D institute dependant on the specific needs that the firm has.
- Policy schemes supporting academic entrepreneurship are often already in place in the Nordic countries. These need to be supplemented by support structures in terms of hands-on management education and support.
- Policy makers need to recognize the overall key importance of education for SME innovation. Measures could be taken to target regional education to the skills and knowledge which SMEs need by. One way to do this is by jointly setting up workshops, courses and training programs. Also, public policy should stimulate the availability of internships at SMEs as part of the curriculum of students. Also mobility schemes offer concrete opportunities to bring the educational sector and SMEs closer together.
- In a learning economy, initial education more than ever needs to be supplemented by the continuous training of employees. Given their limited resource base, SMEs may under-prioritise this issue. Therefore policy measures should be taken that stimulate SME employees to follow updating and refreshment courses to upgrade the firm's knowledge base.

1 Introduction

1.1 Scope and aim of the project

Small and Medium-sized Enterprises (SMEs) have been increasingly recognized by policy-makers as a target group for innovation policy. This requires insight into the role and distinctive characteristics of SMEs in wider production systems and particularly into barriers that SMEs face in enhancing their innovative potential. Given the heterogeneity of the sector, no universal model or set of factors explains how and why innovation takes places. However, it may be safely presumed that limitations in innovative capability are heavily related to the small scope and size of an individual SME. This insight points to the importance of interactive innovation in a systemic context.

The overall aim of the project has been to analyse the need for SMEs in regional clusters to access innovation support at different geographical levels in the context of on-going processes of globalization. This challenges the role of regional innovation systems with respect to the capacity to upgrade the SMEs' knowledge base. Concretely, the project has focused on the following tasks:

Provide a **state of the art overview** with respect to theory, conceptual clarification and research vis-à-vis SMEs and regional innovation systems as well as regional system oriented policies.

Conduct a **comparative case analysis** of Nordic regional clusters and innovation system, in particular focusing on when (what stages in a firm or product's life cycle), for what (which kind of innovations), how (what kind of innovation support) and for whom RIS is most important. This creates insights in what can realistically be done at the regional level in a globalizing economy by acknowledging relationships between the regional, national, international and sectoral levels of innovation systems and support.

Identify **policy implications and recommendations** on the impact of different types of RIS policy in the Nordic countries with respect to promoting competitiveness and innovativeness of SMEs, drawing on the lessons learned from the comparative case analysis.

1.2 The case studies

As unit of research, this project specifically concentrated on so-called clusters of SMEs - commonly defined as a geographically bounded concentration of interdependent firms - and regional innovation systems. The latter contains a specialized cluster of firms plus supporting knowledge infrastructure. In other words, an innovation system involves co-operation between firms and knowledge creating and diffusing organizations, as universities, colleges, training organizations, R&D-institutes, technology transfer agencies. Empirical research has shown that in stimulating innovative activity in clusters of SMEs, it is usually necessary to combine both local and non-local knowledge, skills and competences. On the one hand, regional localized resources - such as a specialized labor market, subcontractor and supplier networks, local learning processes, local traditions for co-operation and entrepreneurial attitude, supporting agencies and organizations and presence of important customers and users - to a large degree stimulate the innovative performance of firms. Nevertheless, the regional level is not always sufficient and firms are often in need of supra-regional (national and international) systems of innovation support.

The purpose of the comparative analysis is to query the existence of similarities and differences between clusters of SMEs in these different regions and sectors and to compare the extent to which regional factors underlie the success or failure of clusters in addition to industry and sector specific factors. Thereby conditions for implementing Regional Innovation System-strategies in the different Nordic regions will be specified, taking account of the diversity of national and regional institutions and cultures. Our knowledge about regional innovation systems draws heavily on case studies of regional success stories, such as the Third Italy or Silicon Valley. Of course, important lessons can be learned from experiences in successful regions but as they hinge upon a specific network of organizations, institutional set-up and localized socio-cultural underpinnings, straightforward copy/paste measures will do more harm than good. Instead, measures ought to be context-sensitive and tailored to the particularity of a location/situation.

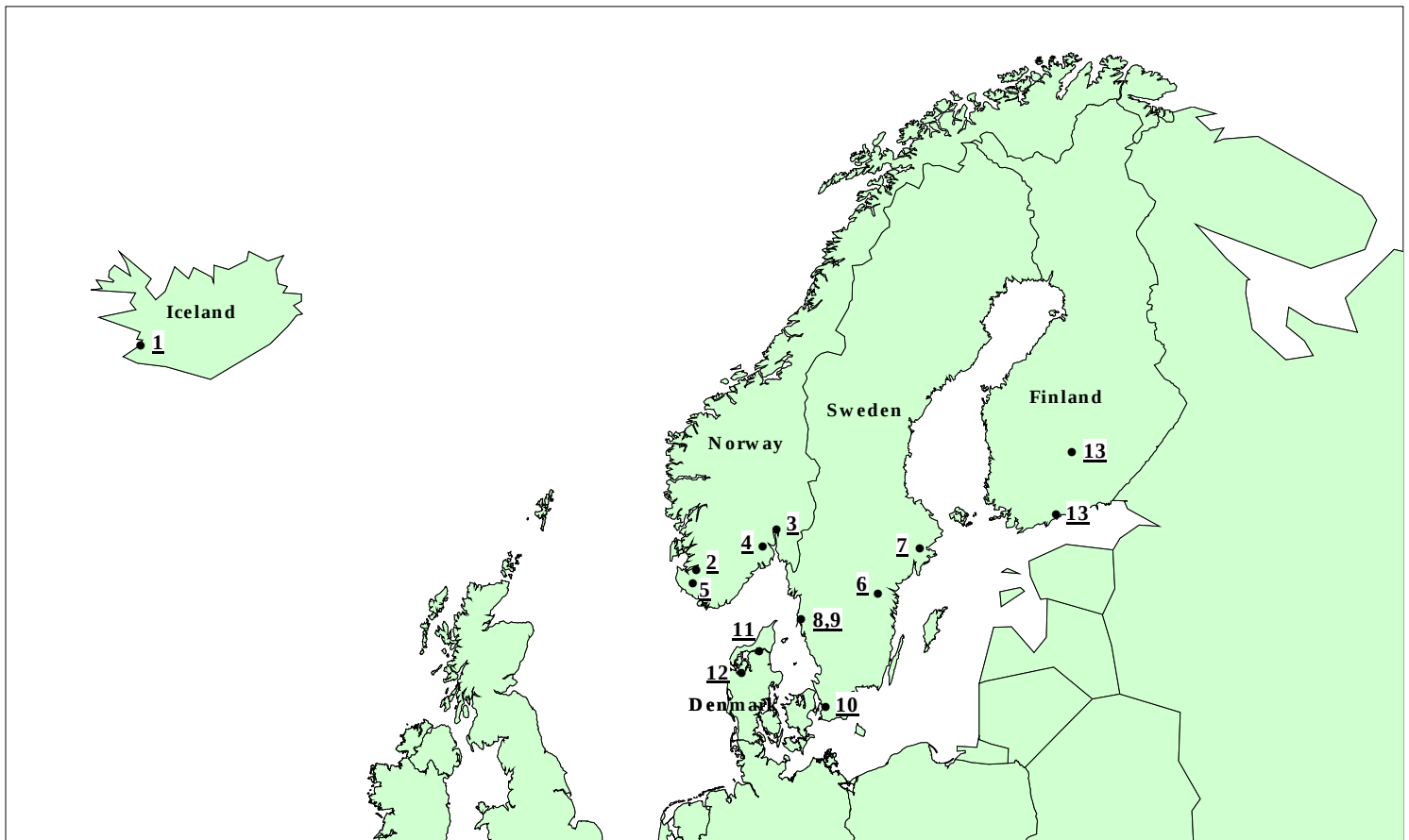
A broad and heterogeneous selection of case-studies has been used, aimed at a deliberate variation in terms of sectors (from low-tech to high-tech) and territories (center – periphery):

- furniture in Salling, Denmark
- mechanical engineering in Jaeren, Norway

- mechanical engineering in Gothenburg, Sweden
- biotech in Gothenburg, Sweden
- functional foods in Scania, Sweden
- food in Rogaland, Norway
- the regional innovation system of East Gothia, Sweden
- electronics in Horten, Norway
- Wireless communication in Aalborg, Denmark
- ICT in Stockholm (Kista), Sweden
- knowledge intensive business services in Oslo, Norway
- the Centers of Expertise Program in Helsinki and Jyväskylä, Finland
- filmmaking in Iceland

Geographical locations of the cases

1: The Icelandic film sector **2:** The Rogaland food cluster **3:** The Oslo KIBS sector
4: The electronics cluster of Horten **5:** The industrial cluster of Jaeren
6: The East Gothia RIS **7:** The Stockholm (Kista) ICT RIS **8:** Mechanical engineering in Gothenburg **9:** Biotech in Gothenburg **10:** Functional foods in Scania
11: The Aalborg high-tech cluster **12:** The Salling RIS **13:** The ICT sectors of Jyväskylä and Helsinki (Finnish Centers of Expertice)



1.3 Outline of the final report

The second chapter provides a conceptual clarification including a state-of-the-art theoretical overview of clusters and regional innovation systems. Hereafter the third chapter gives a short introduction to the case studies including the main findings. The fourth chapter addresses the comparative analysis of the cases, after which policy recommendation are drawn in chapter five. The reports of the individual case studies are not included in this report in an effort to contribute to the preservation of tropical rainforests. These are however accessible via the webpage: <http://www.keg.lu.se/forska/projekt/nordic.htm>

2 Conceptual clarification

2.1 Setting the scene: on the role of innovation and learning

Overview

For more than twenty years regions are growing in importance as a competitive location of economic activities in post-Fordist learning economies (Asheim and Isaksen, 2002; Cooke, 2001). The main argument for this is that territorial agglomeration provides the best context for an innovation based learning economy promoting localised learning and endogenous regional economic development. An important empirical background for this position has been the rapid economic growth of networked SMEs in industrial districts in the 'Third Italy' (Asheim, 2000) as well as other examples of successful regional clustering in most developed countries (Porter, 1990). Bearing this development in mind, this chapter will present an overview of the theoretical arguments underpinning the line of reasoning in the comparative case analysis. First, the role of innovation and competitiveness is discussed. Thereafter follows a brief introduction to the cluster concept, after which the Regional Innovation System (RIS) approach is discussed. This is followed by a brief elucidation on the connections between cluster and RIS. The chapter is concluded by some notes on policy actions.

Innovation and competitiveness in a globalising learning economy

We commence with a pivotal reflection, underpinning the line of reasoning in this chapter. In the contemporary globalising learning economy, competitiveness is based on competitive and not on comparative advantage. It is generally recognised that the theory of comparative advantage is static while the theory of competitive advantage is dynamic, and, thus, can be influenced by innovation policies and supporting regulatory and institutional framework. In this way innovation plays a central role in attaining and sustaining competitive advantage, which means that the distinction between competitiveness and innovativeness is not relevant in a theory of competitive advantage. The concept of innovation originates in the knowledge based economy rationale which identifies knowledge as the most strategic resource and learning as the most fundamental activity for firms' competitiveness (OECD, 1996). By and large innovation refers to new and better ways of

organizing the production and marketing of new and better products thereby implying a wide array of firm activities.

Thus, over the past decades innovation has increasingly been recognized as the driving force for the promotion of competitiveness by firms, regions and nations, representing a major response to intensified competition caused by processes of globalization through the enhancement of the learning ability of firms and workers. An authoritative example of this is the European Commission's 1993 White Paper on Growth, Competitiveness and Employment, which states that

"The key elements in competitiveness that are now of greatest importance are no longer confined to the relative level of the direct costs of the various factors of production. They include in particular the quality of education and training, the efficiency of industrial organization, the capacity to make continuous improvements in production processes, the intensity of R&D and its industrial exploitation, the fluidity of the conditions under which markets operate, the availability of competitive service infrastructures, product quality and the way in which corporate strategies take account of the consequences of changes in society, such as improved environmental protection". (EC, 1993)

In other words, the value of *strong competition*, implying more productive use of inputs, as opposed to weak competition, implying lowest possible input costs, (Storper and Walker, 1989) has become ever more paramount among researchers, managers and policy-makers. This is especially valid for the Nordic countries given the highly advanced welfare system and the accordingly high level of wages. The importance of innovation is moreover further fueled by processes of *globalization* by which we refer to an on-going functional integration of geographically extended patterns of economic activity (Dicken, 1998). Though sometimes depicted as an all pervasive surge of homogenizing and equilibrating market forces sweeping over the world's economic and social landscape, a greater connectedness of cities, regions and nations renders rather specific outcomes for these localities.

A problematic aspect of learning organisations as well as the learning economy in general has been its focus on 'catching up' learning (i.e. learning by doing and using) based on tacit knowledge and incremental innovations, and not on radical innovations requiring the creation of new knowledge. It is, of course, important to underline "the tremendous importance of incremental innovation, learning by doing, by using and by interacting in the process of technical change and diffusion of innovations" (Freeman, 1993, pp. 9-10). Yet, in a long-term perspective in an increasingly globalising world economy it will be even more difficult

for the reproduction and growth of a learning economy to primarily rely on incremental improvements of products and processes, for example in the form of imitation, and not on basically new products (i.e. radical innovations) as a result of, for example, an invention. Crevoisier argues that the reliance on incremental innovations "would mean that these areas will very quickly exhaust the technical paradigm on which they are founded" (Crevoisier 1994, p. 259). This would, in fact, mean that, e.g., imitation was considered more important than (a 'real') innovation, which would be even more problematic if it was based on exogenous learning. According to Nonaka and Reinmöller, "no matter how great the efficiency and speed of exogenous learning, it will not substitute for the endogenous creation of knowledge. The faster knowledge is absorbed, the greater the dependence on the sources of knowledge becomes" (Nonaka and Reinmöller, 1998, pp. 425-26). Thus, in a dynamic and rapidly changing contemporary globalising economy it is necessary to pay attention to knowledge creation as a process that is of equal importance to the processes of learning and forgetting.

Innovation and geographical embeddedness: Local 'sticky' and global 'ubiquitous' knowledge

In a learning economy, which indeed also is a knowledge-based economy (as Lundvall (1992) argues that in our contemporary economy knowledge is the critical resource and learning the most important process), innovation should basically be understood as an interactive learning process, which is socially and territorially embedded and culturally and institutionally contextualized. This implies that competitive advantage is based on exploitation of unique competencies and resources, i.e. a firm or a region/nation competes on the basis of what they have which is unique in relation to their competitors. Unique regional capabilities, rooted in particular patterns of inter-firm networking and inter-personal connections, cannot easily be transferred over space (Asheim and Isaksen, 2002); 'it can only be built up over time' (Lawson and Lorenz, 1999, p. 10). Thus, a strategic perspective in the contemporary global economy is how to develop such unique competencies and resources in order to foster competitiveness based on competitive advantage.

However, research has revealed that the regional level is neither always nor even normally sufficient for firms to stay innovative and competitive. Moreover it points at the additional importance of extra-local (national and international) linkages and connections to create a sustainable competitive advantage. In an ongoing discourse on knowledge and globalisation some authors argue, that as a result of globalisation and

codification processes originally tacit knowledge becomes increasingly ubiquitous, which implies that the competitive advantage of high-cost regions and nations runs the risk of being steadily undermined (Maskell et al. 1998). Other authors argue that much strategic knowledge remains 'sticky' and that important parts of learning processes continue to be localized as a result of the enabling role of *geographical proximity* (e.g. through face-to-face contact) and *local institutions* (e.g. regulation, conventions, informal rules and habits that coordinate economic actors under conditions of uncertainty), constituting region-specific assets that stimulate interactive learning (Asheim, 1999a; Markusen, 1999).

Innovation, disembodied knowledge and local context

The connection between localised learning and tacit knowledge has previously attracted the attention of many scholars. However, localised learning is not only based on tacit knowledge, as contextual knowledge also consists of disembodied codified knowledge. Disembodied knowledge, referring to knowledge and know-how which are not embodied in machinery, but are the result of positive externalities of the innovation process (de Castro and Jensen-Butler, 1993), is often constituted by geographically immobile combinations of place-specific experience based, tacit knowledge and competence, artisan skills and R&D-based knowledge (Asheim, 1999b). The relationship between the codified and tacit elements of disembodied knowledge are often both complex and dynamic. First, the immaterial component of knowledge is increasing generally due to the increased knowledge intensity of the competitive, globalising economy; secondly, part of this immaterial disembodied knowledge is codified or codifiable at a low cost; thirdly, this increases the degree to which knowledge becomes ubiquitous; and fourthly, the economic use of this more transferable knowledge requires, however, that it is combined with other largely sticky and hence localised knowledge.

Disembodied codified knowledge is generally based on a high level of individual skill and experience, collective technical culture and a well-developed institutional framework. Storper (1997) defines such contexts as 'territorialization', understood as a distinctive subset of territorial agglomerations, where 'economic viability is rooted in assets (including practices and relations) that are not available in many other places and cannot easily or rapidly be created or imitated in places that lack them' (Storper 1997, p. 170). This view is supported by Porter, who argues that 'competitive advantage is created and sustained through a highly localised process' (Porter 1990, p. 19).

Lundvall (1996) maintains that “the increasing emergence of knowledge-based networks of firms, research groups and experts may be regarded as an expression of the growing importance of knowledge which is codified in local rather than universal codes. ... The skills necessary to understand and use these codes will often be developed by those allowed to join the network and to take part in a process of interactive learning” (Lundvall 1996, pp. 10-11). Lam (1998a, 1998b) points out that the skills required for knowledge interfacing within and between collective learning processes tend to be highly time-space specific. Interactive, collective learning is based on intra- or inter-organisational routines, tacit norms and conventions regulating collective action as well as tacit mechanisms for the absorption of codified knowledge. This requires that the actors in question have tight connections to the ‘local codes’, on which collective tacit as well as disembodied codified knowledge is based. Thus, depending on the actual architecture of a productive knowledge base, the ability to interpret local codes will be critical for the integration of the operations of a firm within an inter-firm network.

Different knowledge bases: a sector-specific approach

Analysis of the importance of different types of knowledge creation and innovation support (see further below) must however also be placed within a context of the actual knowledge base of various industries and sectors of the economy. The knowledge and innovation process in recent years has become increasingly complex: there is a larger variety of knowledge sources and inputs to be used by organisations and firms and there is more interdependence and division of labour among actors (individuals, companies, and other organisations). Nonaka and Takeuchi (1995) as well as Lundvall and Borrás (1998) have pointed out, that the process of knowledge generation and exploitation requires a dynamic interplay and transformation of tacit and codified forms of knowledge as well as a strong interaction of people within organisations and among them. Thus, the knowledge process becomes increasingly inserted into various forms of networks and innovation systems (at regional, national and international levels).

Despite the generic trend towards increased diversity and interdependence in the knowledge process, we argue that the innovation process of firms and industries is also strongly shaped by their specific knowledge base. Here we will distinguish between two types of knowledge base: ‘analytical’ and ‘synthetic’ (Laestadius, 1998). These types indicate different mixes of tacit and codified knowledge,

codification possibilities and limits, qualifications and skills, required organisations and institutions involved, as well as specific innovation challenges and pressures.

An analytical knowledge base refers to industrial settings, where scientific knowledge is highly important, and where knowledge creation is often based on cognitive and rational processes, or on formal models. Examples are genetics, biotechnology and information technology. Both basic and applied research, as well as systematic development of products and processes are relevant activities. Companies typically have their own R&D departments but they rely also on the research results of universities and other research organisations in their innovation process. University-industry links and respective networks, thus, are important and more frequent than in the other type of knowledge base.

Knowledge inputs and outputs are in this type of knowledge base more often codified than in the other type. This does not imply that tacit knowledge is irrelevant, since there are always both kinds of knowledge involved and needed in the process of knowledge creation and innovation (Nonaka et al. 2000, Johnson and Lundvall, 2001). The fact that codification is more frequent is due to several reasons: knowledge inputs are often based on reviews of existing studies, knowledge generation is based on the application of scientific principles and methods, knowledge processes are more formally organised (e.g. in R&D departments) and outcomes tend to be documented in reports, electronic files or patent descriptions. Knowledge application is in the form of new products or processes, and there are more radical innovations than in the other knowledge type. An important route of knowledge application is new firms and spin-off companies which are occasionally formed on the basis of radically new inventions or products.

A synthetic knowledge base refers to industrial settings, where the innovation takes place mainly through the application of existing knowledge or through new combinations of knowledge. Often this occurs in response to the need to solve specific problems coming up in the interaction with clients and suppliers. Industry examples include plant engineering, specialised advanced industrial machinery, and shipbuilding. Products are often 'one-off' or produced in small series. R&D is in general less important than in the first type. If so, it takes the form of applied research, but more often it is in the form of product or process development. University-industry links are relevant, but they are clearly more in the field of applied research and development than in basic research. Knowledge is created less in a deductive process or

through abstraction, but more often in an inductive process of testing, experimentation, computer-based simulation or through practical work. Knowledge embodied in the respective technical solution or engineering work is at least partially codified. However, tacit knowledge seems to be more important than in the first type, in particular due to the fact that knowledge often results from experience gained at the workplace, and through learning by doing, using and interacting. Compared to the first knowledge type, there is more concrete know-how, craft and practical skill required in the knowledge production and circulation process. These are often provided by professional and polytechnic schools, or by on-the-job training.

The innovation process is often oriented towards the efficiency and reliability of new solutions, or the practical utility and user-friendliness of products from the perspective of the customers. Overall, this leads to a rather incremental way of innovation, dominated by the modification of existing products and processes. Since these types of innovation are less disruptive to existing routines and organisations, most of them take place in existing firms, whereas spin-offs are relatively less frequent.

Local context and innovation: some tentative policy notes

In the perspective of innovation as culturally and institutionally contextualised, strategic parts of learning processes emerge as highly localised, as opposed to placeless. Thus, local contexts can represent important parts of the knowledge base and knowledge infrastructure of firms and regions, underscoring the role of historical trajectories. Governments and agencies at all spatial levels have increasingly become involved in seeking to stimulate innovation, and, consequently, innovation policy is put at the centre of policies for promoting regional and national economic development. At the regional level regional innovation systems and learning regions have been looked upon as a policy framework or model for implementation of long-term, development strategies initiating learning-based processes of innovation, change and improvement (Cooke et al., 2000; Asheim, 2001; Asheim and Isaksen, 2002). However, in order to elaborate further on this point, we need to explore two of the more central concepts in the debate: *clusters* and *regional innovation systems* (RIS).

2.2 Agglomerations, clusters and the creation of competitive advantage

Tracking the cluster concept

Over recent years, the cluster concept has become somewhat of a catchword, in academic circles as well as in the policy discussion on regional economic growth. Below, we will discuss the origins of the cluster concept as well as some recent theoretical developments concerning the conceptualization of clusters and the potential advantages of cluster formation and cluster participation when it comes to innovation performance. Before examining the foundation of the cluster theories as laid out by Michael E. Porter in his work 'The Competitive Advantage of Nations' (1990) we will outline some historical theories and ideas that herald the importance of place and location for economic processes and development.

The origins of the concept: discussions on agglomerations and the post-Fordist economy

In 1909, Alfred Weber published 'Über den Standort der Industrie', presenting the first developed general theory of industrial location (Weber, 1909). His (mathematical) model took into account several spatial factors for finding the optimal location and minimal cost for manufacturing plants: i.e. transportation costs, labor costs and *agglomeration*. The latter refers to the concentration of firms in a locale occurring when there is sufficient demand for support services for the company and labor force. In similar vein, another regional economist, Perroux (1970) argued that territorial agglomeration intensified the growth potential and competitiveness of *growth poles* being firms that are linked together with an 'innovative' key industry to form an industrial complex.

The perhaps most influential classical economist in this context is undoubtedly Alfred Marshall (1921, 1930) who attaches a more independent role to agglomeration economies and forebodes the importance of 'embeddedness' by focusing on non-economic, social-cultural factors for economic development. Whereas Weber and Perroux present an abstract and functional understanding of agglomeration regardless of the specific socio-territorial context, Marshall's emphasizes the particularity of a specific locale. Vis-à-vis agglomeration economies he stresses in particular the mutual knowledge and trust that reduces transaction costs in the local production system; the industrial

atmosphere which facilitates the generation and transfer of skills and qualifications of the workforce required by local industry; and the effect of both these aspects in promoting (incremental) innovation and diffusion among small firms. Such processes are strongly conditioned by the spatial proximity and cultural homogeneity of localities. Marshallian agglomeration economies underlines the importance of non-economic factors associated with territorial concentration of industrial production, and, thus, predates the idea of 'embeddedness' in broader socio-cultural factors (Granovetter, 1985) as a key analytical concept in understanding the working of industrial districts and regional clusters (Asheim, 2000). Early Porterian cluster research and theory building mainly comprised external economies for firms in an industrial cluster, not necessarily linking it with the non-economic aspects of Marshallian agglomeration economies. However, later Porterian thinking was highly influenced by the importance of such agglomeration economies as a result of somewhat unforeseen empirical findings that highlighted the importance of geographical concentration.

A large part of Porter's (1990) important cluster writings emphasize, as we shall discover, on time (i.e. historical technological trajectories) and space (i.e. clusters as territorial agglomerations). This line of reasoning could be tracked back to the work of Piore and Sabel (1984) on the second industrial divide, presenting 'flexible specialisation' (post-Fordism) as an alternative development path of industrialization to 'standardised mass production' (Fordism), as well as to the work of some Italian industrial economists (Beccattini (1990), Brusco (1990)) on 'industrial districts', which demonstrated the potential of networking and cooperating SMEs in a modern economy; to Lundvall's work on the post-Fordist economy understood as a 'learning economy'; and finally, to the recent work of Hall and Soskice (2001) on the 'varieties of capitalism', where the relationships between economic performance and institutional framework is emphasised along with the national innovation and business system approaches (Lundvall and Maskell, 2000).

All these theory traditions form a rather important and significant theory base for arguing the importance of embeddedness of the economy in wider institutional frameworks as well as of time/space contingencies (i.e. historical trajectories and territorial agglomerations). In general, studies have shown that agglomeration economies can represent important basic conditions and stimulus to incremental innovations through informal "learning-by-doing" and "learning-by-using", primarily based on tacit knowledge (Asheim, 1994). As Bellandi suggests, such learning, based on practical knowledge (experience) of which specialised practice is a

prerequisite, may have significant creative content (Bellandi, 1994). Thus, as a result of what Bellandi calls “decentralized industrial creativity” (DIC), the collective potential innovative capacity of small firms in industrial districts or regional clusters is not always inferior to that of large, research-based companies (Bellandi, 1994). Still the fact remains, however, that, in general, the individual results of DIC are incremental, even if “their accumulation has possible major effects on economic performance” (Bellandi, 1994, p. 76).

The Porter ‘Diamond’

Thus, when Porter (1990) introduced in some parts a novel way of conceptualizing extra-firm conditions in an industry’s national context affecting firm competitiveness and performance, many scholars had already for quite some time been interested in how place-specific factors enhanced the competitiveness of firms and regions. Porter’s contribution was however ground-breaking, partly because it highlighted some factors usually not taken into account in regional economic studies, but also because it stimulated a broad debate on regional features as building blocks of competitive home bases. In this respect, Porter and his associates paved the way not just for academics, but particularly for policy-makers in national and regional agencies.

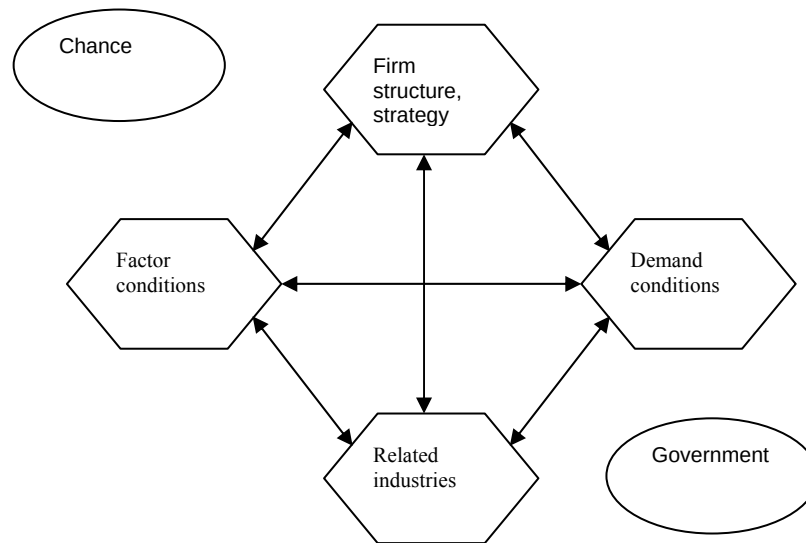
Porter and his associates explained the relative success of certain industries in different countries by specific properties in the national environment in which the studied industry operated. Therefore, a firm owes many of its competitive advantages to its external environment. From being a framework mostly developed to assessing and analyzing the competitiveness of industries at a national level (Porter 1990), Porter’s concepts have in later analytical studies been applied on regional and local levels, i.e. geographically defined clusters, which can be specified as (Porter, 2000, p. 253):

“[...] geographic concentrations of interconnected companies, specialized suppliers and service providers, firms in related industries, and associated institutions (e.g. universities, standard agencies, and trade associations) in particular fields that compete but also cooperate.”

As can be seen above, Porter uses a rather wide definition of geographical clusters concerning the actors involved. Here, we will employ the more strict definition of a cluster as stated in “Regional clusters in Europe:

“A concentration of ‘interdependent’ firms within the same or adjacent industrial sectors in a small geographical area” (EC 2002/ No.3, p. 14).

How then, according to Porter, is competitive advantage created within the cluster? In Porters’ famous ‘Diamond’, the most important building blocks of competitiveness in a cluster are specified. The interacting dimensions of the diamond can be schematized as follows (Porter, 1990):



The Porter Diamond (Porter, 1990)

The *Factor conditions* dimension highlights aspects concerning the importance of the production factors of the economy, that is, it reflects the cost and quality of for example human and natural resources as well as technological, physical and administrative infrastructure. This all boils down to a conceptualization of the specialization and quality of the production factors entering the cluster’s value chain. The dimension *Related and supporting industries* emphasizes the importance of the presence of both internationally competitive suppliers and related industries that can provide the studied industry with for example specialized input goods. This dimension is one of the more interesting ones when it comes to regional intra-cluster cooperation and localized innovative activities. The *Demand conditions* reflects the positive effects of demanding and sophisticated local costumers, for example a demanding home market with progressive consumer preferences. The *Context for firm strategy and rivalry* highlights the positive effects of a localized competitive environment and the localized context under which the firms in question are able to attain the proper levels of investment and upgrading. (Porter 1990; 2000)

Clusters and innovative performance

Porter (2000) argues that the existence of a cluster has positive effects on the competitive advantage of the participating firms in a number of ways, one of them being a positive impact on the *innovation capability* of the firms in the cluster. The pressure to innovate is elevated because of local rivalry, expected to raise the incentives to innovate among firms in the cluster. Innovative activities are further facilitated through close collaboration and complementarities, arising from co-location. The co-location within a cluster provides possibilities of strong relationships between producers and suppliers, engaging local suppliers in the innovative process. Through contacts with other actors within the cluster, firms are able to increase technological knowledge as well as knowledge on consumer preferences and marketing concepts. Moreover, the specialized labor market pool is one of the more important components in this respect, providing the firms in the cluster with skilled personnel, needed to enhance the innovative performance of the cluster. (see Porter, 2000)

Questioning the cluster approach

The connection between regional clustering and positive effects on innovation rates is however somewhat ambiguous in contemporary literature (Martin and Sunley, 2003). Martin and Sunley (2003) point out some of the shortcomings in the state of the art research in proving the alleged positive effects of regional clustering. Still, more detailed research has to be carried out to determine the effects of regional clustering on regional economic competitiveness, growth and prosperity.

In their recent article, Martin and Sunley (2003) are expressing a critical view of the cluster concept and the way in which it has entered the domain of academics, consultants and policy makers. In fact, they argue that

“Clusters, it seems, have become a world-wide fad, a sort of academic and policy fashion item.” (Martin and Sunley, 2003 p. 6)

Martin and Sunley (2003) attribute the popularity¹ of the cluster concept to several factors, among which are the relatively easy accessible focus on

¹ Primarily among economic geographers, but these arguments can according to our view be generalised to explain the popularity of the cluster concept in a broader sense.

competitiveness, skilful 'branding' of the cluster concept as a framework combining theoretical as well as practical aspects (including a theoretical framework expressing affinity with 'business strategy' rather than with wider and more complicated debates on different modes of regulation), and the elasticity of the concept itself suited to analysis of multiple industries and circumstances.

In the sense of academic rigour, there is ample opportunity to criticize the Porterian approach to clusters. In terms of demands of a sound academic theory, Martin and Sunley (2003) rightfully identify a major source of confusion and annoyance in Porter's practice of discussing and studying the occurrence of clusters and the event and effects of cluster dynamics. Martin and Sunley (2003) identify two major definition problems in the writings of Porters. The first major problem in defining clusters lies in the delimitation of the clusters, spatially as well as industrially. Industrially, it is a delicate question how to delimit the cluster, in terms of the range of activities included in the cluster and the links between them, as well as in the requirements on the degree of regional specialization. Spatially, it seems highly unclear as to within which boundaries 'real' cluster dynamics, for example spillover effects, can arise and operate. Second, Martin and Sunley (2003) point to the fact that the social dimension, deemed so important in facilitating the event of cluster dynamics, is insufficiently theoretically developed and defined in Porterian cluster thinking. However, outside the writings of Porter, the value of for example 'social capital' is often more thoroughly discussed in a local context.

Lessons from the debate: on the importance of the cluster approach

Partly in response to the critical standpoints of Martin and Sunley, Benneworth and Henry (2003) have developed a multi-perspectival approach to the theoretical and practical applications of the cluster perspective. The cluster concept and theories should perhaps not be regarded as a single unitary theory on the creation of competitive advantage developed by Porter from 1990 onwards. Rather, it could be looked upon as consisting of a plurality of perspectives being assembled under the cluster umbrella, developed and re-developed by scholars emanating from a number of different disciplines:

"[...] clusters thinking is a web of inter-dependent academic thinking, policy making and consultants' work." (Benneworth and Henry, 2003, p 6)

In spite of the critique directed towards the cluster concept, Benneworth and Henry (2003) argue that it is of great significance in terms of its acknowledgement of local (and regional) dimensions compared to more general (global) ones. Moreover, the cluster approach offers possibilities of a broader understanding of the creation of territorially specific advantages, in ways not only conceptualized in terms of the most 'successful' regions. Finally and, according to Benneworth and Henry most important, the diversity of the clusters makes the cluster approach salutary in the comprehension of uneven regional economical development. Even though Benneworth and Henry do not, in an academic sense, completely solve the Gordian knot of the cluster approach, their contribution is interesting in terms of their effort to create a synthesizing approach to cluster studies, based on contribution from a wide range of academic disciplines and approaches. Thereby, the theoretical complexity of the cluster approach can be used as an important instrument in uncovering the regional dynamics of territorially defined clusters.

Malmberg (2003) argues that Martin and Sunley fail to consider some of the novelties that have been brought forward by the development of the cluster approach, for example in the treatment of factor disadvantages and the importance of local rivalry and sophisticated customer demand. Malmberg (2003) attributes much of the conceptual confusion concerning clusters to the fact that clusters can be seen as both industrial and spatial phenomena, that is, either confined to industrial systems defined from a functional view, or delimited by geographical boundaries. But instead of regarding these multiple definitions of the cluster as highly problematical, Malmberg seem to recognize the possibilities of using both definitions.

Malmberg's categorization is however of further interest, as he notes that industrial systems defined from a functional standpoint seldom can be found entirely inside a local context (Malmberg, 2003). Partly as a result of this, it seems necessary to acknowledge the importance of local as well as global functional links between firms and between firms and other organizations. As Malmberg notes:

"[...] when approaching spatial clusters from the point of view understanding how such milieus become sites of learning and knowledge creation, we need both theoretical and empirical analyses of the different qualities of local and global interaction." (Malmberg, 2003 p. 17)

Interestingly enough, several scholars in economic geography today emphasize the combination of local and regional based knowledge and dynamics as paramount in establishing and sustaining firm competitiveness. As for the spatially defined clusters, Malmberg (2003) however notes the importance of a specialized labour market (that is, a market of skills and competence), potentially of great significance to the competitiveness of the cluster.

2.3 (Regional) Innovation Systems

Origin of the concept

The concept of regional innovation system (RIS) is a relatively new one, which appeared in the early 1990s (Cooke, 1992, 1998, 2001), a few years after Chris Freeman first used the innovation system concept in his analysis of Japan's economy (Freeman, 1987), and approximately at the same time as the idea of the national innovation system was becoming more widespread, thanks to the books by Lundvall (1992) and Nelson (1993). Characteristic for a systems approach to innovation is the acknowledgement that innovations are carried out through a network of various actors underpinned by an institutional context. This dynamic and complex interaction constitutes what is commonly labelled as the system of innovation (Edquist, 1997). A set of variations on this approach have been developed over time, either taking territories as their point of departure (national, regional and metropolitan) or specific sectors or technologies.

The National Innovation Systems approach highlights the importance of interactive, reciprocal *learning* and the role of nation-based *institutions* in explaining the difference in innovation performance and hence, economic success, across various countries. In discussing innovation in this context, it should be noted that when reference is made to innovation as a crucial means of competition in the knowledge based economy it is not the previous hegemonic linear model of innovation (R&D → invention → production) but a new understanding of innovation as basically a socially and territorially shaped, interactive learning process that cannot be understood independently of its institutional and cultural contexts (Lundvall, 1992). To a large extent the 'system' dimension was inspired by the same literature, and the rationale of having territorially based innovation systems (national and regional) is the same, i.e. either the existence of historical technological trajectories based on 'sticky' knowledge and localised learning that can become more innovative and

competitive by promoting systemic relationships between the production structure and knowledge infrastructure in the form of national or regional innovation systems, or the presence of knowledge creation organisations whose knowledge could be exploited for economic useful purposes through supporting new emerging economic activity. In addition, the idea of regional innovation systems was inspired by agglomeration theories within regional science and economic geography (e.g. growth pole theory etc.) as well as the success of regional clusters and industrial districts in the post-Fordist economy (Asheim, 2000; Asheim and Isaksen, 1997).

As a result of empirical studies which have emphasized the significance of the regional level in economic development (over the national level), a strong case was made for an approach geared to region-specific innovation activities. The kernel of the argument is that close *proximity* between organizations strongly facilitates the creation, acquisition, accumulation and utilization of knowledge rooted in inter-firm networking, inter-personal relationships, local learning processes and 'sticky' knowledge grounded in social interaction (Asheim and Isaksen, 2002).

RIS: embeddedness and systemic dimensions of localized innovation processes

The localized character of the RIS is reflected in one of the earlier definitions of a regional innovation system: it being a system in which firms and other organizations are systematically engaged in interactive learning through an institutional milieu characterized by embeddedness (Cooke et al. 1998). The crux of this definition lies in the notion of embeddedness. This refers to the importance of personal relations and networks ingrained in a local social and cultural context (Granovetter, 1985). Without it the definition would equal the definition of a national innovation system writ small. Additionally, a regional innovation system can be conceptualized as regional clusters surrounded by 'supporting' knowledge organizations (Asheim and Isaksen, 2002). Thereby the regional innovation system is boiled down to two main types of actors and the interactions between them. The first actors concern the companies in the main industrial clusters in a region as well as their support industries (e.g. customers, suppliers). The second type of actors backing up the innovative performance of the first type of actors include research and higher education institutes, technology transfer agencies, vocational training organizations, business associations, finance institutions etcetera.

The formation of regional innovation systems (RIS) must be understood in this context of creating a policy framework aiming at a systemic promotion of localised learning processes in order to secure the innovativeness and competitive advantage of regional economies (Freeman, 1995; Cooke et al., 2000). A regional innovation system involves co-operation in innovation activity between firms and knowledge creating and diffusing organisations, such as universities, colleges, training organizations, R&D-institutes, technology transfer agencies, business associations, and finance institutions. These organizations hold important competence, train labour, provide necessary finance etc. to support regional innovation².

The notion of a regional innovation system involves a strategic institutionalisation of innovation between the private and public sectors in a systemic way, constituting an institutional infrastructure as a «superstructure» to the production structure of a region. The concept region recognises the existence of an important level of industry governance between the national and the local (Asheim and Cooke, 1999). Regions are, thus, seen as important bases of economic coordination at the meso-level: 'the region is increasingly the level at which innovation is produced through regional networks of innovators, local clusters and the cross-fertilising effects of research institutions' (Lundvall and Borrás, 1997, p. 39). To varying degrees, regional governance is expressed in both private representative organisations such as branches of industry associations and chambers of commerce, and public organisations such as regional ministries with devolved powers concerning enterprise and innovation support, particularly for SMEs. Furthermore, there are few regions that do not possess increasingly important universities or polytechnics that can look outward to industry either for research commissions or as incubators for innovative start-up firms.

The systemic dimension of the 'RIS' derives in part from this team-like character associated with innovation in networks. While, as Lundvall (1992) puts it, an innovation system is a set of relationships between entities or nodal points involved in innovation, it is really much more than this. Such relationships, to be systemic, must involve some degree of

² This conceptualisation of regional innovation systems corresponds with the one found in Cooke et. al (2000). In their words any functioning regional innovation system consists of two sub-systems: (i) the knowledge application and exploitation sub-system, principally occupied by firms with vertical supply-chain networks; and (ii) the knowledge generation and diffusion sub-system, consisting mainly of public organisations.

inter-dependence; not all relationships may be equally strong all of the time, but some may be. Likewise, not all such systemic relations need be regional, but many are, and as out-sourcing grows more are likely to become so.

A typology of regional innovation systems

Extensive studies conducted by Maillat (1991) and Perrin (1988) conclude that there are two main types of innovation network (Asheim and Cooke, 1999):

- *The endogenous innovative network* is based upon a pre-existing regionally or locally delineated cluster of small and medium enterprises. They will have had a lengthy tradition of interacting and learning from one another, successfully competing on the basis of, as needed, co-operative innovation practices. Examples of such endogenous innovative networks are to be found in southern Germany (e.g. Baden-Württemberg) and the Third Italy (e.g. Tuscany or Emilia-Romagna).
- *The exogenous innovative network* takes the form of technopoles or science parks. They tend to emerge in two kinds of circumstances: (a) when large firms fragment their production structure and locate R&D activities in functionally specialised zones where synergies are expected to arise from co-location (as in Sophia Antipolis or Lille in France), or (b) by planned innovative milieus established to promote collaboration between universities and SMEs (as in science parks in the UK and USA).

Falling between these two approaches are innovative networks which develop in or near already existing metropolitan areas and combine characteristics of both the endogenous and exogenous type. Large and smaller scale firms establish network relationships with universities, other firms, research institutes, and government agencies.

This basic distinction between endogenous and exogenous innovation strategies can be used to construct a typology of different types of regional innovation systems (RIS). In both the analytical and political light it is important to recognize that different types of regional innovation systems exist, especially vis-à-vis its interplay with the national innovation system. For this we draw on the generally accepted distinction made by Asheim (2002), which resembles the work done by Cooke (1998), between '*regionalised national innovation system*', '*territorially embedded innovation systems*', and '*regional networked innovation systems*'. A schematic representation is found the table below:

Type of RIS	Location of knowledge organizations	Knowledge flow	Important stimulus of cooperation
Type I: Regionalised national innovation systems	Many outside the region	More linear	Individuals with the same education and common experience
Type II: Territorially embedded regional innovation network	Locally albeit few relevant knowledge organizations	Interactive	Geographical, social and cultural proximity
Type III: Regional networked innovation systems	Locally, a strengthening of (the cooperation with) knowledge organizations	Interactive	Planned systemic networking

Some characteristics of the three main types of regional innovation systems (based on Asheim and Isaksen, 2002)

The first type may be denoted as *territorially embedded regional innovation systems*, where firms base their innovation activity mainly on localised learning processes stimulated by geographical, social and cultural proximity without much interaction with knowledge organisations. This type is quite similar to what Cooke (1998) calls “grassroots RIS” and implies a broad definition of innovation systems which incorporates “all parts and aspects of the economic structure and the institutional set-up affecting learning as well as searching and exploring” (Lundvall, 1992, p. 12).

The best examples of *territorially embedded regional innovation systems* are networking SMEs in industrial districts. Thus, in Emilia-Romagna, for example, the innovation system could be said to be territorially embedded in spatial structures of social relations within that particular region. The rationale for such territorially-embedded systems is to provide a bottom-up, network-based support (e.g. through technology centres, innovation networks or centres for ‘real services’) for the ‘adaptive technological and organizational learning in territorial context’ (Storper and Scott, 1995, p. 513).

The territorial embedded RIS can be further developed into *regional networked innovation systems*. The firms and organisations are still embedded in a specific region and characterised by localised, interactive learning. However, the systems have a more planned character through the intentional strengthening of the region's institutional infrastructure – for example, through a stronger, more developed role for regionally based R&D-institutes, vocational training organisations and other local organisations involved in firms' innovation processes. The networked system is commonly regarded as the ideal-typical RIS: a regional cluster of firms surrounded by a local 'supporting' institutional infrastructure. Cooke also calls this type "network RIS".

The networked innovation system represents an *endogenous* development model as an attempt to increase innovation capacity and collaboration through public policy instruments. For SMEs, in particular, in order to carry out more radical innovations there is often a need to supplement their informal, tacit knowledge with competence arising from more systematic research and development. In the long run most firms cannot rely exclusively on localised learning, but must also have access to wider pools of knowledge on a national and global basis. The creation of regional networked innovation systems through increased cooperation with local universities and R&D-institutes, or through the establishment of technology transfer agencies, centres for real services, may provide access to information and competence which supplements firm's locally derived competence. This not only increases their collective innovative capacity, but may also serve to counteract technological "lock-in" (the inability to deviate from an established but outmoded technological trajectory) within regional clusters of firms.

The networked regional innovation systems represent a planned interactive enterprise-support approach to innovation policy relying on close university-industry cooperation. Large and smaller firms establish network relationships with other firms, universities, research institutes, and government agencies. The '*network*' approach is more typical of Germany, Austria and the Nordic Countries and distinct from the endogenous, Italian industrial district approach to technology and innovation support as well as the linear-model, exogenous approach, of which science parks and technopoles are most representative.

The third main type of RIS, *regionalised national innovation system*, differ from the two preceding types in several ways. First, parts of industry and the institutional infrastructure are more functionally integrated in national or international innovation systems – i.e. innovation activity

takes place primarily in cooperation with actors outside the region. Thus, this represents more of an *exogenous* development model. Cooke (1998) describes this type as “dirigiste RIS”, and implies a narrow definition of an innovation system incorporating the R&D functions of mainly universities, research institutes and corporations. Secondly, the collaboration between organizations within this type of RIS is largely based on the linear model, as the cooperation mainly involves specific innovation projects to develop more radical innovations and with the use of formal scientific knowledge typically in industries with an analytical knowledge base. Within such systems, cooperation is most likely to arise between people with the same occupational or educational background (e.g. as engineers). This functional similarity facilitates the circulation and sharing of knowledge through ‘communities of practice’, whose membership may cross inter-regional and even international boundaries (Amin and Cohendet, 2003).

Examples of a *regionalised national innovation system* could be found in the clusters of R&D laboratories of large firms and/or governmental research institutes in planned ‘science parks’. These may be located in close proximity to universities and technical colleges, and normally have weak and limited linkages to local industry (Asheim, 1995; Henry et al., 1995). In general science parks tend to have weak local cooperative environments (Henry et al., 1995), which result in a failure to develop inter-firm networking and interactive learning in the parks, while technopoles are characterised by a limited degree of innovative interaction between firms in the poles, and by vertical subcontracting relationships with external firms (Asheim and Cooke, 1998). This all implies a lack of territorial embeddedness and leads to questions about their capability for promoting innovativeness and competitiveness on a broad scale in local industries (especially the SMEs) in particular regions, as a prerequisite for endogenous regional development. However, there is normally better networking between R&D institutions, firms and the local state in regionalised national innovation systems than in national ones.

Regional innovation systems and SMEs

At this stage it is important to realize that the aforementioned (clustered) firms often consist of SMEs. SMEs have been increasingly acknowledged by policy-makers as a target group for industrial and innovation policy, following a re-emergence of the small firm sector in western industrialized countries since the mid 1970s. One of the key underlying objectives of policy intervention is to help SMEs to overcome any size-

related barriers that may limit their innovative capability. Yet, the *diversity* that exist within the SME sector, the *particularity* of different geographical contexts and the intrinsic *uncertainty* of the outcome of innovation implies that there is no pre-given single model or set of factors that adequately explains how and why innovation takes place. This calls for a *varied yet integrated* set of policy instruments in order to stimulate innovation capability in SMEs. In our view, the regional innovation approach offers an adequate framework, yielding sufficient flexibility and coherence to meet the requirements for this task. Previous research (e.g. the SMEPOL project) found that actual policy to across-the-board upgrade regional innovation systems is seldom found and needs to be more developed. Such upgrading entails stimulating interactive learning between firms and in collaboration with different kinds of supportive knowledge organizations, inspired by a systems perspective on innovation (Asheim et al, 2003).

New directions for regional innovation systems

However, it also needs to be emphasized that the regional innovation systems approach is continuously further qualified on the basis of empirical application. Two main lines of development can be distinguished. Firstly, the regional innovation systems approach bears the risk of falling victim to a regional gaze, falsely considering the region as a closed-off container. In line with the previous typology suggested by Asheim (1998) which stresses the importance of extra-regional dependence vis-à-vis knowledge flows for regional clusters of firms, more and more researchers are arguing that a sustainable strategy towards innovation in regional clusters quintessentially combines both local and complementary non-local skills and competences in order to go beyond the limitations of the region. This is considered necessary in order to avoid the local innovative capability to dry up by allowing 'fresh' knowledge and learning processes to enter the local knowledge base. This argument will undoubtedly be reinforced by globalization processes and further developments within ICT-technology which will have consequences for the relevant types and scales of innovation systems necessitating a multi-level approach to innovation systems.

The second qualification can be seen as a response for this call to open up or permeate the geographical boundaries of a regional innovation system and addresses the question which elements of the system remain truly regional: in short, people. In this respect, labour is identified as a marked immobile foundation of a regional innovation system (Hommen and Doloreux, forthcoming). Key persons' experience based knowledge as

well as artisan skills are a vital supplement to formal scientific knowledge in innovation processes. This informal knowledge base includes both 'know-how' and 'know-who'. Moreover, this kind of knowledge is 'stuck' to individuals whom hold the most valuable first-hand experience of this knowledge and how to put it into use and cannot be moved without the holder of the knowledge moving too. Furthermore it is partly embedded in local patterns of interaction. So far, the acknowledgement of the value of local labour markets and human skills is scarcely found in studies and policy for regional innovation systems (Henry and Pinch, 2002) yet promises a fruitful line of development.

Finally, the emphasis on interactive learning and collaboration between various knowledge organizations furthermore reminds us of the primacy of soft development factors for the economic performance of regions such as social capital (e.g. trust) and institutional learning. In order to foster endogenous regional development previous research (in particular on Nordic regions) has highlighted the importance of regional development coalitions (Asheim, 2000). By this is meant a bottom-up horizontally based collaboration between different actors in a regional setting, such as workers and managers within firms or in networks of firms, but also generally the mobilization of resources in a broader societal context in order to become a 'learning region'. Yet such a strategy cannot be applied across the board without some form of public intervention as well as public-private co-operation and therefore paves the way for policy-makers to re-think ways to achieve competitive development in as well as of regions (Asheim, 2001).

2.4 Connecting Clusters and Regional Innovation Systems

An explicit, categorical conceptual clarification on the linkage between on the one hand clusters and on the other regional innovation systems has so far received relatively little attention in the literature. As we have seen, traditionally, regional innovation systems denote regional clusters surrounded by innovation supporting organizations. Here, the relation between clusters and regional innovation systems takes its vantage point in the simplest form of cooperation within a cluster which can be described as territorial integrated input-output (value chain) relations. The next step of formally establishing inter-firm networks is represented by a purposeful, functional integration of value chain collaboration as well as building up a competence network between the collaborating

firms thereby taking a more systemic (i.e. planned) approach and representing a development from vertical to horizontal forms of co-operation. This entails a more closely coordinated interaction between industry and knowledge creating and diffusing organizations. Notwithstanding Porter's recent (and aforementioned) extension of the cluster concept which more or less eliminates the differences between clusters and regional innovation systems, we argue for a more systematic approach distinguishing between the cluster's knowledge base and the extent of loose / tight linkage with the regional innovation system. The traditional constellation of regional clusters surrounded by potentially innovation supporting organisations is nearly always to be found in contexts of industries with a synthetic knowledge base (e.g. engineering based industries), while the existence of RIS as a necessary part of the development of an emerging cluster will normally be the case of industries based on an analytical knowledge base, such as IT and bio-tech. In both of these cases it is a question of regional clusters exploiting localisation economies (e.g. sectoral specialised clusters).

Sectoral specialisation can, however, be the result of different industrial development paths. In traditional cluster-regional innovation system relations, based on industries with a synthetic knowledge base, the logic behind building regional innovation system is to support and strengthen localised learning of an existing industrial specialisation, i.e. to promote historical technological trajectories based on 'sticky' knowledge. In contexts of a regional innovation system as a necessary part of the development of the emerging clusters, it is a question of promoting new economic activity based on industries with an analytical knowledge base, requiring close and systemic industry-university cooperation and interaction in the context of e.g. science parks, located in proximity of knowledge creating organisations (i.e. (technical) universities).

2.5 Some notes on policy strategies on clusters and RIS

As can be deduced from the discussion above, different industrial sectors, in terms of size and forms of organisation, have different requirements of innovation systems and innovation policy. There are obviously differences in demand between locally controlled SMEs (including their subcontractors/suppliers), large locally-controlled firms (including their supply chains), subcontractors/suppliers for firms outside the region, and branch plants. While the first category of firms

primarily needs the support of interactive, territorially embedded regional innovation systems or regional networked innovation systems, the last three categories largely demand their services from the national innovation system and international, sectoral innovation systems. The second category of large, locally-controlled firms can, of course, also make use of regionalised national innovation systems. In addition, depending on the sectors of the firms, the services of regional networked innovation systems can be used. Even R&D-dominated industries can benefit from the broader view of interactive learning as central to innovative activities, and especially by exploiting the increased impact of territorial agglomerated local production systems on firms' competitive advantage (Asheim and Isaksen, 1997).

The regional innovation approach, for example, does not only exist as a framework to study economic and innovative performance but it is also in use as a concrete tool for policy-makers to systemically enhance localized learning processes to secure regional innovativeness in practice (which in turn influences the functioning of the regional innovation system as such). Industrial and regional policies have during the last decade increasingly focused on stimulating regional clusters and (increasingly) RIS, mainly based on well-known examples of affluent regions containing dynamic clusters of firms, as well as the fact that traditional policy strategies have not worked satisfactorily.

However, the rush by policy makers to employ 'cluster ideas' has run ahead of many fundamental conceptual, theoretical and empirical questions (Martin and Sunley, 2003). This has triggered a lively academic debate concerning also the implementation of cluster policies in regional development schemes. From a critical perspective, Martin and Sunley (2003) express their doubt concerning some of the cluster policy initiatives taken by actors in or close to policy circles. However, they point out four usual ways of providing public goods in the context of cluster policies:

- establishment of dialogue between firms and other agencies and establishment of co-operative networks
- marketing of place in terms of regional specialization
- provision of service and research facilities
- attraction of investors to fill in the "gaps" in the cluster (based on value chain evaluation)

According to Martin and Sunley, the implementation of cluster policies is full of pitfalls. Not only is there a problem of exclusion and 'picking the

winners', but Martin and Sunley (2003) call on policy-makers to be wary also of the potential drawbacks of cluster policy and cluster promotion due in part to the exaggeration of the importance of local environment and regional specialization on firm performance. Clusters may for example suffer from lock-in tendencies and inflation in labour wages and land costs, and Martin and Sunley argue furthermore that:

"The danger of a cluster-based approach to policy is that it detracts from the need to make a more holistic view of regional development." (Martin and Sunley, 2003, p.28)

In this context, it seems pivotal that policymakers are aware of the contemporary theoretical developments concerning regional development and regional clustering. It is the intention that this report may contribute to this objective, through a critical examination of the carefully selected case studies.

2.6 Summing up: clusters and RIS as nodes in the economy

Based on the line of reasoning in this chapter, there is a strong case to make today that regional clusters and innovation systems are important modes of economic coordination in post-Fordist learning economies (Asheim and Isaksen, 1997; Cooke, 2001) due to the existence of localised learning and "untraded interdependencies", i.e. 'a structured set of technological externalities which can be a collective asset of groups of firms/industries within countries/regions and which represent country- or region-specific 'context conditions' of fundamental importance to the innovative process' (Dosi 1988, p. 226). In general, "geographical distance, accessibility, agglomeration and the presence of externalities provide a powerful influence on knowledge flows, learning and innovation and this interaction is often played out within a regional arena" (Howells 1996, p. 18). Close cooperation with suppliers, subcontractors, customers and support institutions in the region will enhance the process of interactive learning and create an innovative milieu favourable to innovation and constant improvement. This influences the performance of the firms and strengthens the competitiveness of the clusters, and is increasingly seen as an important aspect of fostering regional competitive advantage. Generally, the innovative capacity at the regional level can be promoted through identifying "the economic logic by which milieu fosters innovation" (Storper, 1997).

3 Summary of the case studies

3.1 Overview

The empirical base of the project is formed by 13 case studies on different clusters of SMEs and regional innovation systems in the Nordic countries. Below, an introduction to the individual cases and the main results are presented. The *Salling* case provides an informative point of departure on highly innovative low tech SMEs in a cluster context located in a peripheral part of Denmark. After this, the case of *Jaeren*, provides a contrasting picture of the development of a traditional industry in a peripheral region. Another example of the dynamics of a traditional industry, yet in a core region, is provided by the mechanical engineering in Gothenburg case. In addition, we also discuss the high-tech biotech sector in this region. This high-tech focus continues in the Scanian case on functional foods. Scania is traditionally a stronghold of food production in Sweden. The next region, Rogaland, fulfils a similar role in Norway but in a more peripheral context. The case of East Gothia provides an across-the-board picture of the regional innovation system but especially emphasises the ICT sector. This sectoral focus can also be found in the subsequent cases of Horten, Aalborg and Stockholm. After Stockholm, another capital region, Oslo, is discussed from the perspective of its knowledge intensive business sector (KIBS). The KIBS and ICT-sectors are also discussed from a Finnish perspective. However, the case of the Finnish Centres of Expertise provides a more policy oriented vantage point. The case of the Icelandic film industry concludes this section.

As implied, this introduction provides a short overview of the case studies. The complete conclusions and description of the different cases can be found in the original texts, available via the webpage:

<http://www.keg.lu.se/forska/projekt/nordic.htm>

3.2 Furniture in Salling, Denmark

The Salling cluster comprises 7 Danish municipalities. Throughout the latest 15 years, outputs of and occupation within furniture production in the Salling district have grown considerably (especially in connection to the penetration of Danish furniture exports into new markets, e.g.

Germany). The reason is that its economic and institutional structures are well matched, with patterns of social trust and communication lowering co-ordination costs and allowing for flexible inter-firm relations. Salling has demonstrated a remarkable ability to change its economic as well as institutional structures according to external market conditions, in a process of localized learning.

Salling firms have explored new markets, branded products, and developed new designs. This has not only meant growth of some existing producers - it has also encompassed numerous start-ups of new small firms. Today, in spite of some firms that have grown to a considerable size, the average size of Salling furniture firms is still small. The small size of most firms seems not to hinder their economic development - which is to a large degree independent of the larger firms. Recent downturns in international furniture markets have led to some decline of the district, and local firms now struggle to reorient themselves to new markets, preserving the decentralised cluster structure. Many firms now engage in strategic alliances in order to compete with integrated competitors abroad.

The case study first maps the economic and institutional structures of Salling, and presents an account for how institutions facilitate local innovation. Next, it presents an analysis of localized learning in Salling, concluding that even if such processes should be viewed as evolutionary, there is still scope for policy measures. For example, stimulating the emergence of a system of many co-localised and specialised firms hinges upon *stimulating entrepreneurship*. While norms and conventions of entrepreneurship are not easily stimulated by policy, direct support for start-up of new firms through finance schemes and entrepreneurship services may make it easier for newcomers to enter into an industry, or for employees to spin off their own company. In particular, Salling illustrates that even if external finance may not seem important for product innovation in low-tech industries, it may still be crucial for product innovation in the longer run, because by stimulating new start-ups, it may be possible to boost an entire system allowing for user-producer innovation and other innovations (which, as a bonus, quickly may become self-financing). In-service education may also be important not only for process innovation in single firms, but also for creating an innovation system through making it possible for people to cross over from one industry to another.

In order to stimulate collaboration among local firms, policymakers may fund practical assistance for writing of contracts and other mechanisms of

governing inter-firm relations. However, as illustrated by Salling, local conventions and trust, facilitated by local civic interaction and communication was the crucial factor behind collaboration. Of course, it is impossible for policymakers to redesign social institutions like norms and conventions, but as seen in Salling, many such institutions may change relatively quickly, and policymakers may stimulate the process of institutional learning through addressing its frame. Policymakers should also be aware of the potential of inspiring new generations of workers and entrepreneurs (or, literally, sons and daughters of existing entrepreneurs) to stay and invest in the local area, in order to preserve skills, traditions, and civic networks. This may constitute a larger challenge, as many industrial areas, old as emerging, seem to conduct less and less attraction to the younger generations, prone to move to urban and more “creative” areas.

3.3 Mechanical Engineering in Jaeren, Norway

The Jaeren regional cluster is located in a region south of Stavanger in the South-western part of Norway. Rogaland, the county where Jaeren is located, is the largest industrial county of Norway. The economy of Rogaland is dominated by oil and gas industry and mechanical engineering industry, traditionally specialising in the production of farm-machinery, the latter constituting the cluster under study. The case study investigates the role of a regional innovation system in the development of an internationally competitive cluster of firms located in Jaeren. It is argued that the basis for the competitive strength of these firms, which are highly exposed to both international price- and quality competition, can be found in the historic existence of specific innovative capabilities developed endogenously in the region and embedded within it as “untraded interdependencies”.

However, at present the regional production system is under increasing duress, both as a result of what will be argued is the internal logic of the system itself, and as a result of contingent, external forces. This industrial cluster, which for many years has been very competitive and export oriented, has undergone considerable changes during the last ten years due to the globalisation of the world economy and changes in ownership structures. These processes have had big consequences for the regional organisation for technical co-operation, TESA, which was established by the local firms already in 1957, and which has played a key role in the development of industrial robots, where Jæren is the leading region in

Norway. As a result of the potential tensions between the corporations and their local subsidiaries with respect to control and loyalty, all the firms belonging to large corporations, independent of national or foreign ownership, are no longer members of TESA. Thus, this case study can be used to throw light on the role of regional innovation systems in regions exposed to challenges from the global economy in general and from FDI's specifically.

Particular emphasis is put on duress caused by divergent specialisation paths, international expansion and foreign ownership in the region, and how the main containing structure of the innovation system – the formal cooperation of TESA – has responded to this pressure and attempted to redefine itself.

3.4 Mechanical Engineering and Biotech in Gothenburg, Sweden

These case studies are focusing on technology-based SMEs and clusters in the Gothenburg region. In the analysis of the Gothenburg clusters, the role and importance of technology-based entrepreneurship, the labor knowledge pool and universities (as well as other organizations) is described. The Gothenburg region is characterised by a heavy specialisation in traditional industries, e.g. machinery and automotive production. This specialisation may present a growth problem if renewal does not take place. However, there are signs that the economy of the region is being developed also towards other fields, especially IT, which provide opportunities and challenges for SMEs. These processes of regional renewal and transformation are studied in two ways.

First, the processes by which knowledge production and use may draw upon the existing regional knowledge base as well as 're-combined' to create new innovation opportunities. Knowledge production in the Gothenburg region often draws on the traditional regional industries. While Sweden in the traditional fields of biotechnology and bio-science seems to be rapidly developing in Stockholm/Uppsala and Malmö/Lund, the Gothenburg region seems to be falling behind. The reason is that the region lacks a 'critical mass' of activities in the traditional knowledge base of biotechnology. However, new fields seem to emerge which draws on a number of formerly unrelated knowledge fields, which in turn may assist in transforming the traditional regional industry structure. This process of regional renewal and the creation of a new regional innovation

system may be particularly true in the bio-sciences. Therefore, the case analyses how and why Gothenburg, lacking academic and industrial "strength" in the traditional fields of the bio-sciences, instead may move into emerging areas of the bio-sciences.

Second, the different roles that large firms, universities, and firm spin-offs play. Technology-based SMEs in the Gothenburg region are usually born in the form of spin-offs from large firms and universities. Spin-offs from large firms often demonstrate substantial growth, while spin-offs from universities in general stay small. Instead of exploiting innovative ideas to expand their own operations, university spin-offs are often found to sell these ideas to larger firms. Large firms' acquisition of innovative ideas, i.e. often from university spin-offs, may also form a basis from which additional corporate spin-offs may be formed. Thus, both kinds of spin-offs have important but different roles to play in the regional innovation system.

3.5 Functional foods in Scania, Sweden

The province of Scania, located by the Øresund in the most southern part of Sweden, is by tradition an important centre for agricultural production. The strong agricultural sector in the region, implying strong historical links and occurrence of path-dependency tendencies, is likely to be one of the reasons why several of the largest and most successful food processing industries in Sweden are located in Scania.

The total growth within the food cluster in Scania, however, is quite low, even though parts of the Scanian food cluster are expected to show a substantial growth rate during the coming years. Some of the activities in the cluster are mainly based on "low-tech" labor intensive production. In the light of severe future competition on agricultural bulk products, partly due to the entrance of new members in the EU, it is regarded as crucial by many actors within the cluster to increase the value added in the food production.

Functional foods is frequently regarded as an area of high future growth. A handful of SMEs in this emerging field are located in and around Lund, where the largest university in the Nordic countries is located. In the case study, the companies' innovative practices are put in context. The study begins with analysis of three knowledge-intensive companies in the

functional food area, and then works outwards to other actors and factors that are important in the region, on the national level and internationally.

The study reinforces the idea of the significance of a multilevel approach to innovation systems. The companies work together with traditional food companies on regional, national, and international scales, as well as with research groups and organisations on all these scales. Still, three companies in the new field of functional foods are located in the Lund region. Regional characteristics with close proximity to major food companies and Lund University (with many researchers in fields such as food technology, medicine, nutrition and a tradition of firm-university co-operation in the food biotechnology field), makes it not so surprising to find these functional foods SMEs there. The case study shows that location matter, but perhaps relationships to researchers at Lund University are more important than the firm-firm interactions.

3.6 Food in Rogaland, Norway

The Rogaland case study analyses the development and dynamics of the food-related regional innovation system (FRIS) in Rogaland. The Rogaland food RIS is one of the most complete RIS in Norway. The case analyses how a 'mature' agglomeration, over the last decades gradually has changed to a more dynamic agglomeration stimulated by a FRIS with many new institutions and innovation networks stimulating new growth of SMEs and enhanced competitiveness of firms. The historical conditions for the development of FRIS seem partly to be the scale and scope of the food cluster (producers and subcontractors based on many different raw materials as agro, aqua and fish), supporting industries and institutions, and partly socio-cultural traditions for cooperation inside and between the food sector and other sectors.

Contingent conditions which have activated FRIS-strategies are connected to a combination of deregulation and liberalization of food production and trade, local industrial crises and the oil industry as a demanding food market. It is only during the last 10-15 years that the FRIS has been developed in a systematic manner, primarily by proactive horizontal strategies for innovation between local and regional actors in the private and public sectors. In the last years the FRIS has also to an increasing extent been integrated in global innovation networks, both by international R&D-networks but also by investments in the cluster by transnational firms. As such it seems that the food cluster is going to be

stronger integrated in a multilevel innovation system, but where the regional and the global systems seems to strengthen their role.

The case concludes that SME-innovation policy must be adapted to specific regional contexts, resources and challenges. In light of the challenges facing the food cluster in Rogaland, an innovation policy needs to be tailored to avert system failures and overcome hurdles to innovation in areas such as capital requirement in the pre and post phases of development work, need for expertise, distribution and market hurdles, interaction between firms and knowledge organisations, information and competence sharing and confidence building, and the need of innovation-service.

3.7 The regional innovation system of East Gothia, Sweden

The region of East Gothia is located in the south eastern part of Sweden. The region has a somewhat higher proportion of employees within manufacturing and mining than does Sweden as a whole. It also has a higher percentage of employment in the sector producing Research and Development (R&D) intensive products. This is particularly true for the city of Linköping, where we find the region's university and the Mjärdevi Science Park. Electronics and computer science activities dominate both of them.

The case study sets out to examine and describe the innovation system of East Gothia. It focuses on the industrial and organisational structure, including the knowledge infrastructure, of the regional innovation system, together with the processes and practices that have shaped its nature and its dynamics. Drawing on a variety of both primary and secondary sources, the case maps the core elements and actors that have contributed to the recent development of the region, examining the relations among firm strategy and performance, trajectories of innovation, the availability and use of technological resources, and patterns of relationships among actors.

The results reveal that the East Gothia innovation system is more well developed in some places than in others. The region also has parts of its industrial structure and knowledge infrastructure that are more closely integrated into national or even international systems. This is especially the case with regard to manufacturing linkages in innovation processes

involving partners from outside the region, but also with respect to large firms, which are more integrated within their own productive systems. The main challenge for East Gothia is to develop structures and policies that can combine and co-ordinate disparate elements and actors within a coherent regional system of innovation.

3.8 Electronics in Horten, Norway

The Horten case study analyses in particular the relationship between the regional, national and international level of innovation systems and support. The electronics industry in Horten comprises about 1.900 jobs and 25 firms, thus constituting one of the largest electronics clusters in Norway. Five of the firms have more than 100 employees. Business relations in Horten are historically integrated in national, and increasingly in international, rather than local economic structures. System houses and OEM-suppliers mainly collaborate with national and international partners when innovating. Nevertheless, the local level has revealed increasing significance for some parts of the innovation activity in the electronics industry in Horten since the 1980s. Thus, the subcontractors ever more use the regional innovation system.

Policy efforts to strengthen the regional innovation system have been introduced. The case study examines to which extent this effort has led to more regional collaboration and use of regional resources in firms' innovation activity, in order to examine the potential role of the regional level in this kind of high-tech industries. This case study thus contributes to the debate about the process of knowledge creation and innovation in regional clusters by considering the usefulness of the 'local buzz – global pipeline approach' in the case of the electronics cluster in Horten. The approach emphasises that a cluster's continued economic success is based both on local interaction, or the cluster's buzz, and on interaction through trans-local pipelines. The paper argues that the approach provides a helpful insight into how innovation and learning take place in the electronics cluster. However, in the case of Horten the approach can fruitfully be supplemented with approaches focusing on internal knowledge creation and firms' intellectual capital, on persons' interaction in national business communities, and on firms' involvement in global value chains.

3.9 Wireless communication in Aalborg, Denmark

In the region of North Jutland a cluster of firms specialised in wireless telecommunications has emerged in the most recent 25-30 years closely connected to the build-up of Aalborg University from 1974, as well as the Aalborg Science Park, NOVI, from 1989. The cluster consists of around 40 firms with an employment of 4000 persons and has since 1997 been organised in the cluster association NorCOM (www.norcom.dk). The NorCOM cluster forms the core of the broader ICT sector of North Jutland with 8-9000 employees.

The success of the NorCOM cluster, in terms of co-operation between the private sector, Aalborg University and the science park, NOVI, has been a central background behind a government decision in 1999 to launch a major project on Digital North Jutland (DDN) during 200-2004. The county council of North Jutland has been appointed as the major responsible actor for the DDN project, which basically is set up to facilitate the further diffusion of IT in the region and to create a broader competence in the IT service and software development industries. Another part of DDN concentrates on the IT-infrastructure of the region.

Recently empirical studies have focused on how capabilities of new entering firms are important for the evolution of industries over time. The performance of new entrants appears to be significantly influenced by their pre-entry background. The general impression of the literature is that firms founded by former employees of successful incumbents have shown larger propensities to survive than other categories of new entrants. In the case study, this approach is used to study the emergence and growth over the past three decades of a wireless telecommunications cluster around Aalborg in North Jutland, Denmark (NorCOM). The study shows that the technological successes of firms in the region have powered a spinoff process, which can account for the majority of the growth in a number of firms and employment in the cluster.

3.10 ICT in Stockholm (Kista), Sweden

The success story of the Kista cluster evolved from one large telephone and computer company, Eriksson, enjoying extremely favourable national and regional conditions. The Nordic countries host the most advanced users of mobile telephony and the Internet. Stockholm is considered the leading market in wireless access to the Internet. Sweden

hosts several regional IT-clusters, with Stockholm-Kista being the largest one. The Kista IT cluster is a part of the new NUTEK strategy of cluster development in Sweden. It also gets attention at the regional level, as Stockholm is trying to become a more competitive city in Northern Europe.

The ICT university and the industry has a highly advanced form of co-operation through the “Kista Integral”, as well as the test bed for new wireless applications, in the Campus Network, to be developed into a city – wide open access wireless broad band (Stockholm Open) to be used in University research on new wireless applications.

The case study discusses that after the ICT boom-bust, large-scale corporations are no longer able to organise the highly skilled local workforce, and bind them to the corporate mast. As a result, more knowledge is now increasingly territorially embedded, and available as a basis of new firm creation, based on innovations. The study suggest that the entrepreneurial firms which emerge under these circumstances start off as small temporary organisations, most of them with short life spans – to be deleted after the test of the basic idea – but some with a genuine expectancy and potential to grow through industrial up-scaling and global market interpenetration. They typically are initiated as project teams, composed of partners with different, and complimentary skills, who share the same idea, framed within the core set of different knowledge and expertise partners are able to bring along. The study shows that the institutional embedding of these fragile project groups is in the case of Kista organized within the framework of a formalized innovation system, called KIG (Kista Innovation and Growth).

3.11 Knowledge intensive business services in Oslo, Norway

The Oslo case study analyses the role and importance of business service and venture capital in the regional and national innovation system. The ‘knowledge intensive business service’ (KIBS) sector is supposed to make a special contribution to competitiveness and innovation in other industries. KIBS are in particular seen as bridging institutions in innovation systems as producers of intermediate inputs, i.e. bridging the knowledge infrastructure of universities, R&D-institutes etc. and firms. Co-location of business service firms and other firms may stimulate knowledge flows and collaboration between KIBS and other industrial

sectors. Business service is clearly over-represented in the Oslo area (Oslo and Akershus county). Areas like Oslo that are over represented by business service *may* have better prospects for industrial development than areas that are under represented, although firms may of course co-operate with more distant firms and organisations. The more informal knowledge flow is, however, stimulated by geographical proximity.

The case examines the role of KIBS for innovative activity in particular in the 'new economy' sectors in the Oslo area, as well as the potential role of business service in the Oslo area as a node in the national innovation system. In addition, the study also looks into the financial system for promoting the establishment and growth of SMEs. In spite of a widespread recognition of the financial system as a very important element in an innovation system, the study of the system of finance is often neglected in innovation studies. The case study takes this challenge seriously through mapping the financial system for the support of innovative SMEs in the Oslo region.

The case study argues that public support for innovation is less apparent among service firms than among commodity producing firms, suggesting that public support systems have been directed towards traditional and industrial R&D. Since small firms often are confronted with unique financial problems that constrain their performance, it is important to draw attention to these shortcomings. Small firms to a large degree rely heavily on their own savings and on short-term liabilities to finance investment, and knowledge based firms are more likely than "conventional firms" to face financial constraints. Venture capital and seed money is not much used by the KIBS-firms in the case study, but the portfolio survey indicates a financial gap just for these industries in their early stages.

3.12 The Centers of Expertise Program in Helsinki and Jyväskylä, Finland

The Finnish economy has since the 1990s been branded a growth ICT economy, and the success stories of individual regions have been branded "miracles" in terms of dealing with the severe constraints of economic recession in early 1990s. Much of the explanation has been based on social capital aspects and on the ability of SMEs to adjust themselves to new conditions and place themselves strategically vis-à-vis the big businesses. The two Finnish case studies were selected as

examples of divergent regional cases and as representatives for divergent Regional Innovation Systems: one marked by the special status of capital growth region (Helsinki), with the institutional thickness and business environment that capital status entails, the other as a small and “up-and coming” ICT region (Jyväskylä), that has both the advantages and disadvantages of a medium-sized urban region in Finland.

Otaniemi was the first innovation cluster in Finland, housing both a wide variety of businesses and research facilities (including the Technical Research Centre (VTT), and the Helsinki University of Technology). Though the ‘innovation network’ has expanded geographically (for instance through the university campus’s new locations such as *Viikki*, *Meilahti* or *Arabianranta*), Otaniemi is undoubtedly still the most central location in Helsinki region’s innovation network. Technology Park is also institutionally an important core location, as it houses both Innopoli (the meeting-point and business generator for institutions of higher education and research in the Helsinki metropolitan area, incl. Spinno, providing support services including venture capital investments for businesses) and Culminatum (Helsinki Region Centre of Expertise).

Jyväskylä is one of the most interesting cases in terms of innovation based regional policies in Finland. The fields of expertise in Jyväskylä region Centre of Expertise are i) information technology (especially linking to so called wellness technology), ii) control of paper production and iii) energy and environmental technology. Jyväskylä is one of the few regions, that have successfully gone through structural change from a traditional industry based region into an information economy based region. However, Jyväskylä’s focus is not only on the R&D of ICT-technology, but also in so-called “wellness technology”, which refers to business activity and technology related to the maintenance of health, medical treatment and rehabilitation as well as independently managing of one’s life. Private business activity in the sector of social and health care has started to develop quickly during the last few years. The research and education of health, both mental and physical, is strong in this region. However, the traditional paper cluster is not forgotten, but also linked to other field of expertise (ICT and energy and environmental technology). Another notable feature of Jyväskylä region is the successful regional co-operation, which has reflected positively to the overall strategy.

3.13 Filmmaking in Iceland

Film making has become an important industry in all the Nordic countries, where production of full feature films is seen as the highlight of the trade, while works for television and multimedia is seen as the economic or commercial backbone of the trade. Each country has produced between five to fifteen feature films a year and the focus of interest has shifted between the countries, first Sweden, then Denmark, Finland, Iceland, Denmark again and now Norway. Filmmakers have for a long time encountered the problem of high cost by collaborating, often across borders. Such collaboration has been encouraged by supra-national entities such as the Nordic Council and the European Union. The grants have been justified by culture-political arguments. Nordic/European film production is seen as a countermeasure against the American or, more precisely, Hollywood's, dominance. In recent years these networks have started to live a life of their own in the sense that cross border collaboration has become permanent and often deep-rooted. The technological development in recent years (digitalization) and the lowering of the production/entrance barriers do not seem to have diminished the cross-border collaboration. In fact, it seems that the development towards a more multi media orientated technology has even increased the need for a cluster like collaboration.

The focus of the case study, filmmaking in Iceland, is important in many respects despite its minimal contribution to the GNP. It is on the border of being defined as an industry, seen concurrently as art and industry. Filmmaking is also viewed as one of the precedents of the so-called new economy, continuously threatened by other forms of media and, for the Icelandic economy, one of the first industries to become truly integrated into the shift towards Globalisation. Since 1977 or the beginning of the so-called "spring" in Icelandic film production, close to one hundred feature films have been made. Its importance lies in its visibility and, perhaps, multiplier effects.

4. Comparative case analysis

4.1 Introduction to the comparative analysis

The following chapter provides a comparative analysis of the case studies. For a detailed account of the cases we refer to the particular appendices. Given the wealth of data we choose to limit ourselves to a set of main themes and common observations in the case studies. The first section mainly touches upon the linkages between SMEs, innovations and innovation systems embracing a broad perspective. By only looking at the role of the regional innovation system (RIS) the analysis would run the risk of constructing 'a wall' around the region and neglecting important extra-regional linkages. Instead this section takes account of the globalizing knowledge economy and therefore also includes national and international innovation linkages.

After adopting this wide geographical perspective, we return however explicitly to the local by comparing the cases through the cluster concept. In this context a strong case is made for local collaboration and innovation in partnership as a key to enhancing SME competitiveness. Therefore, section three outlines the importance of social capital as a cornerstone for collaborative innovation. It can actually be argued that in the face of the globalizing knowledge economy, social capital constitutes a crucial regional asset that strongly conditions the relative importance of the regional innovation system vis-à-vis national and international knowledge linkages. The case studies demonstrate clearly how social capital can be built and maintained by networking initiatives between firms and other knowledge agents. As such, it can be considered as a cornerstone for regional collaboration and learning between SMEs and other regional knowledge agents and thereby for the international competitiveness of Nordic SME. Finally section four looks specifically at the role of the regional knowledge infrastructure for Nordic SMEs. Here we argue that especially the local supply of skilled labour is an important feature from which SMEs benefit the context of innovation.

4.2 SMEs, innovations and innovation systems: a broad perspective

Overview

As defined in the conceptual clarification, innovations are new and improved ways of organizing the production and marketing of novel products. Furthermore it is recognized that innovations are not an act of solitary genius but rather carried out through a network of various actors underpinned by an institutional context. This dynamic and complex interaction makes what is commonly referred to as the system of innovation. *Firstly* the case studies show that the ability to innovate forms the key for SME competitiveness in a globalizing economy, especially in the high-wage Nordic countries. This is the case both for high-tech sectors as well as for traditional low-tech sectors.

Secondly, it is argued that systems of innovation on regional, national and even the international level play complementary roles for Nordic SMEs. Dependant on the market orientation of the firms, provision of skilled labour pools, traditions of collaboration and most importantly the availability of various relevant competences in regional, national or international knowledge infrastructures, SMEs tend to collaborate with knowledge actors on various geographical levels. This implies new challenges to regional innovation systems.

In connection with this, the case studies demonstrate, *thirdly*, that SMEs are relatively more dependant on a globally distributed knowledge for R&D driven innovation activities. In contrast, SMEs that are more dependent on user-producer learning tend to create innovations by localized interaction. This distinction can be related to the type of knowledge base that the firm holds and build upon. While an analytical knowledge base with a strong science component mainly draws on R&D driven global knowledge flows, a synthetic knowledge base with a strong engineering component mainly draws on local interactive learning.

Innovation as the basis for competitiveness in high, medium & low-tech SMEs

A central feature of all the case studies is the prime importance of innovation for the competitiveness, survival and prosperity of SMEs. In this, a variety of related forms (product, process and organizational) mechanisms (R&D driven, user-producer interaction) and degrees (radical, incremental) in innovation can be identified. Innovativeness at

large is a key-issue not only within high-tech clusters - as could be anticipated by mere virtue of its technological orientation – but also within medium and low-tech clusters. This goes against the commonsensical idea that the lower the level of technological advancement, the lower the innovativeness of an industry / cluster.

Examples: the cases of Salling, Gothenburg, Horten and East-Gothia

The case of furniture production in **Salling** demonstrates that a typically low-tech and traditional manufacturing sector can actually be highly innovative and competitive. A very strong case is made for the idea of strong competition building on a more productive use of input underpinning longer-term competitiveness as opposed to a weak competition based on achieving the lowest possible input costs. The regional furniture producing system in Salling has survived and prospered throughout the last 25 years in spite of its high factor costs. The reason for this is the collective and individual ability of the SMEs to innovate and change to shifting market conditions allowing for flexible specialization, innovating through interacting and jointly addressing problems of export market penetration and scale economies. Qu a medium tech, the mechanical industry in **Gothenburg** shows how the cluster constantly renews its scientific and technological dynamism by spawning new firms as spin-offs from other firms or university, local inter-firm cooperation and the availability of a skilled labour pool trained by the local universities. With regard to the more obvious high-tech sectors, the case of electronics in **Horten** demonstrates that the ability to innovate lies at the core of the SMEs prosperity as the successful commercialization of scientific knowledge fundamentally determines a company's performance. On a more aggregated level, the research conducted on manufacturing firms in **East Gothia** confirms our argument that the propensity to innovative, having a broad definition in mind, is similar between low-tech, medium-tech and high-tech firms.

Multi-level innovation systems: regional, national and global

The case studies clearly provide proof that innovation in a SME is not a solitary act but strongly dependant on collaboration with other firms and knowledge generating and diffusing organizations. Conclusions from earlier research on SME capability to innovate, as conducted through the European SMEPOL project, are supported in the sense that a single model or set of factors adequately explaining how and why innovation takes place cannot and should not be expected. Notwithstanding this, the innovation systems approach offers a highly appropriate analytical and

policy framework to study and enhance SME innovativeness, given its emphasis on systemic relationships between various actors.

A regional innovation system seems to be the most natural support structure in boosting SME performance by virtue of geographical proximity and local institutions, yet several case studies challenge this viewpoint and point at the additional importance of innovation systems at the national and international level for firms in regional clusters. A prominent factor underpinning the relative importance of an innovation system is the availability of relevant knowledge and competence bases that meet the needs of the particular firm in a particular situation be it on a regional, national or international level. A set of conducted case-studies illustrate this very clearly.

Examples: the cases of Gothenburg, Scania, Iceland, Horten, Rogaland and Salling

The conducted research shows that both the biotech SMEs in **Gothenburg** and **Scania** predominantly ally up with global players. In fact, the vast majority of the SMEs' collaborative agreements in Gothenburg are established with other actors on a geographically global level (63% of all formal collaborative agreements). An explanation to this phenomenon may be that many small firms do not attempt to commercialize their ideas by releasing a new product themselves as this is far too costly. Instead they sign agreements with large global corporations that have resources (both competence-wise and financially) for clinical trials, marketing & sales, distribution, patent offices, etc. Nonetheless, the firms also rely on actors in the regional innovation system to uphold their innovative performance. This relationship mainly consists of knowledge transmission between the SMEs and local universities. This is demonstrated by the high level of co-production of patents and scientific publications and the importance of the universities of respectively Lund and Gothenburg for the provision of a highly competent labour pool from which the SMEs first and foremost draw their employees. It can thus be argued that the clusters in Scania and Gothenburg have a global market orientation yet a local labour connection. In a somewhat different context, the **Icelandic** case yields similar results. Here, the cluster remains embedded in the local context, despite an increasingly international market orientation due to the availability of a local competence base and the economic use of the incumbent scenic landscape for film making.

A different pattern can be distinguished for the cases of the electronics cluster in Horten and the food cluster in Rogaland. These clusters are

typically dependent on innovation systems found on both the regional and the national level. Research found that Horten's electronic cluster has two main upgrading mechanisms. First, the cluster includes numerous local suppliers that provide important local external economies as they comment on and specify drawings for new products, build prototypes and perform pilot production. Second, an important strength of the firms is the large, internal competence in firms acquired as a result of employed key persons. However, this 'empersoned' competence mainly comes from national R&D milieus. Moreover, the firms have co-operated right from the start with large Norwegian knowledge organizations and partly with important national clients on product development. Rogaland displays quite similar interaction patterns. Here, research found that local businesses obtain essential R&D capacity and services from R&D organizations in the region as well as from across the country. A large proportion of these locally based institutions are R&D divisions of wider, national organizations albeit with a strong regional focus in areas like competence-building, collaboration and contracting (as exemplified by the activity field of the Norwegian Institute of Fish Processing and Preservation Technology; Nordconserv). It can be argued that as regards to the cluster – innovation systems interaction, these two cases display a hybrid form of regionalized national innovation systems and regional networked innovation systems given the dual embeddedness of the clusters in both national and regional innovation systems. A contrasting case is made by the Salling cluster. Here we can witness a text-book example of a local innovative network. A lengthy tradition of interacting and learning between SMEs as well as with the local technical school, the local producers' association and local industrial service institutions is underpinning the remarkable performance of this low-tech industry.

On a general level it can thus be argued that regional, national and international systems of innovation play complementary roles for clusters of SMEs dependant on the market orientation of the firms, provision of skilled labour pools, traditions of collaboration and most importantly the availability of matching competences in regional, national or international knowledge infrastructures.

Localised user-producer learning versus globalised R&D driven innovation

In this multi-level innovation system perspective, another important observation can clearly be made on the basis of the conducted case studies. R&D driven innovation processes (as illustrated by the

biotechnology cases in Scania and Gothenburg) feed mostly into global knowledge flows while innovation through user-producer interaction (as illustrated by furniture production in Salling) has a more localised character. Localised interactive user-producer learning processes are often seen as one of the most important features of a well-developed cluster. In a cluster dense co-operation between firms and their suppliers is often facilitated and improved by spatial proximity. The transaction costs are lower, and the presence of social capital (see 3.3) can further enhance learning on a vertical basis among actors in the cluster. Dense linkages between users and producers are furthermore a way to reap the benefits of economies of scale and scope that normally are available only to larger firms.

However, also national or even global networks of learning and innovation are of great importance, not at least in industries with extreme demands on highly advanced state of the art knowledge. A distinction can be made between analytical (science-based) and synthetic (engineering-based) knowledge bases. When a firm is mainly involved with innovations based on an analytical knowledge base, for example in biotechnology, this entails global collaboration on the basis of joint R&D as the matching, often unique, knowledge is concentrated in specific sites of the globally distributed knowledge base. Innovation strongly evolves around the creation of new knowledge. Firms that depend on a synthetic knowledge base for their innovative performance, such as furniture production, organise their collaboration to a much greater extent through localised user-producer interaction. Here, innovation evolves around the application of existing knowledge or via new combinations of knowledge. In the concrete practice of a SME analytical and synthetic knowledge bases can of course co-exist while also global and local innovation linkages not necessarily exclude each other.

Examples: the cases of Salling, Oslo, East-Gothia, Gothenburg and Scania

In the case of **Salling**, strong localised user-producer networks are one of the reasons for the competitiveness of the cluster. The Salling end producers have a tendency to subcontract specialised inputs within the cluster. It is of great importance to recognise that these stable relations often are trust-based. Examples of more flexible vertical relationships can also be found. These include the local introduction of subcontracting assignments and establishing relations to new suppliers. Within the Salling cluster, user-producer interaction is essential to arrive at new product designs, the core of the competitive advantage in the cluster. Even though some firms use specialised services outside the local innovation system (e.g. designers), a high proportion of the

innovation and learning activities take place inside the Salling production system, in part due to strong localised inter-firm relations and specialisation of suppliers. The rich availability of nearby suppliers makes it possible for end producers to alter the design of the product in co-operation with suppliers. It also enables them to shift suppliers in accordance with the demands of the customer. Furthermore, as the local production network displays a wealth of relations and specialised firms, local producers may level out fluctuations in demand by subcontracting and outsourcing within the cluster.

Evidence from the KIBS-cluster in **Oslo**, suggest that in-house competence and vertical linkages are of major importance for the competitiveness of the firms. User-producer interaction plays a crucial role to the firms within the cluster, as the firms mainly sell specially designed products to end-users on local or national markets. There are however differences in the dependency on the localised networks that can be attributed to firm size. SMEs within the Oslo cluster seem to be more embedded in local networks than larger firms, and therefore to have a larger appreciation for the local context.

In the **East Gothia** innovation system, interaction between users and producers is central to the learning processes associated with product innovation. This observation is valid throughout the value chain of the end producers, since suppliers as well as customers are regarded as important collaboration partners to many firms, notably 'suppliers of material and components' and 'private customers'. The most important regional collaboration partners for many firms seem to be suppliers and customers. However, a substantial number of firms declare that their most important collaboration partners are located outside the region of East Gothia.

In the case of mechanical engineering in **Gothenburg**, many firms regard interaction with customers as highly important. This is true on a regional as well as on national scale. However, it should be noted that the relationships with customers are more valuable to the companies on a national scale than on a regional or global scale. Regarding supplier-user relations, the local dimension is of the greatest importance, and here co-operation with global suppliers are of very low significance. The results from the Gothenburg mechanical engineering cluster display a complex picture, and, interestingly, the statistical evidence does thus not show that the local dimension is more important than the national in terms of co-operation with other actors within the innovation system.

As opposed to the importance of the local level in interactive user-producer networks discussed above, some of the other studies in this report show a quite different picture. The firms in the **Scanian** functional food agglomeration and the biotech cluster in **Gothenburg** display highly spatially distributed learning patterns, in some cases in fact truly globalised. The innovation processes in biotechnology are highly R&D driven. As regards formal inter-firm collaboration, the biotech firms in Gothenburg tend to predominantly team up with other firms on a global level. It needs to be stressed however that less than the majority of firms actually conduct formalised co-operation, and findings from the Gothenburg biotech study suggest that firms rely to a much larger extent on internal capabilities than might be expected. As a result of these findings, it can be argued that learning is conducted on a world-wide basis, rather than on a local or regional. The production and learning system of the Gothenburg biotech cluster seem therefore heavily engrained in global knowledge networks, while the localised vertical relationships seem of lesser importance. In the case of functional food firms in Scania, the picture is somewhat the same as in the Gothenburg biotech cluster. Even though the firms in Lund are embedded in a regional knowledge infrastructure and have co-operation with traditional food-processing companies within the region, the firms seem to be heavily dependant on learning processes taking place on a global level.

4.3 SMEs, clusters and cluster life-cycles

Overview

In the previous section, the focus was set on SMEs, innovation and innovation system. In this section, we will change perspective primarily addressing the cluster concept. In the conceptual clarification we defined a cluster as a concentration of interdependent firms within the same or adjacent industrial sectors in a small geographic area.

The comparative analysis below will focus on three major topics. Horizontal and vertical collaboration among SMEs in a cluster raises their competitive advantage by pooling resources and taking advantage of economies of scale and scope normally only available to larger firms. We discuss various examples of Nordic SMEs engaged in successful cluster collaboration, but also provide examples where such collaboration is hampered. Secondly, we argue that the phase in the cluster life cycle, in terms of growth-maturity-decline, needs to be taken into account when

analyzing the innovative behaviour of the cluster's firms and their competitiveness. Thirdly we discuss the relationships between large firms and SMEs in different types of clusters. SMEs are often dependent on large firms but these dependencies display different characteristics in different clusters and in different industries.

Horizontal and vertical cluster collaboration

An essential *internal* (endogenous) force stimulating the competitiveness of a cluster is the positive potential of collaboration amongst firms in a cluster. One way of understanding inter-firm relationships is by considering co-operations in a vertical and a horizontal dimension. In co-operating vertically, firms collaborate with suppliers, customers and other agents throughout the value chain of a given product. Horizontal co-operation on the other hand involves co-operation between competitors, specialised in more or less the same stage in the production hierarchy. Intensive horizontal co-operation in innovation may therefore seem more problematic than vertical, as it raises questions on the propensity of firms to conduct in-depth collaboration efforts with competitors.

However, one of the prime features of a cluster is the ability of firms in the cluster to compete *and* to co-operate and one of the most salient areas to undertake collaboration efforts is indeed innovation. Research on the industrial districts in Third Italy has furthermore demonstrated that the collective upgrading of the knowledge base among SMEs can result in a shift from vertical to horizontal collaboration. As the majority of the firms have become dedicated to their own production methods and products, the scope for non-competitive horizontal collaboration is increased. Below we discuss various examples of Nordic SMEs engaged in successful cluster collaboration, but also provide examples where such collaboration is hampered

Examples: the cases of Jaeren, Salling, Rogaland, East Gothia and Oslo

In the **Jaeren** mechanical engineering cluster, the network organisation TESA stimulated the evolvement of horizontal co-operation efforts. During the institutionalisation phase in 1967-1970, emphasis was put on developing co-operative arrangements and initialising research efforts in areas such as industrial electronics and automatisisation. The focus on production technology was central, as competing in different markets with heterogeneous products while using similar technologies enabled the firms to horizontally open up towards each other, building trust and relational assets. This outlines an important feature of TESA and the

Jaeren cluster, since it involves horizontal collaboration in the development and implementation of production technology in firms with very different products. However, as the common denominators have decreased among the TESA firms due to increased specialisation and increased foreign ownership, the value of being part of TESA has been hollowed out, putting the foundation for horizontal co-operation within the Jaeren cluster into question.

In the **Salling** cluster, both horizontal and vertical co-operation is of great value to the innovative capabilities of individual firms. Horizontal innovation collaboration within the cluster comprises of development of new product lines for end producers (incorporating the development of 'total solutions'), new product brands (establishment of common brands within networks of firms or joint co-operation to achieve environmental certification), new marketing and sales processes (co-ordination of marketing efforts and joint attempts in new market introduction), and new production facilities. Salling is furthermore an interesting example of a cluster where some SMEs collaborate horizontally to achieve economies of scale, in machinery, joint subcontracting or storage, and sometimes even in the establishment of production facilities abroad. Vertically, user-producer interaction is essential to arrive at new product designs. Apart from the strong user-producer relations within the Salling cluster, often having a stable, long-term character, more flexible interaction patterns are also of great importance, especially in product innovation processes. New varieties of products can be offered the market through the altering of supplier structures. The great numbers of suppliers also has implications on new product designs in the sense that users and suppliers together can work out new designs that are both possible to market and feasible production-wise.

The **Rogaland** food cluster features an interesting aspect of horizontal co-operation. Within the cluster, initiatives have been taken toward collaboration between actors in the food cluster and actors in culture, tourism and other services. This way of jointly creating added value through horizontal networking between industries can also be seen in the Scanian food cluster. The development is interesting, since it might raise the attractiveness of a region, promoting sale of regional products and, sometimes, when it comes primarily to high-quality products, even internationally. In terms of vertical collaboration resulting in innovations, the Rogaland food cluster displays many examples of such co-operation in the recent years, especially among SMEs. For example, firms have co-ordinated their specialised knowledge in different parts

in the value chain to promote product innovations in high-quality segments of the food market.

In the **East Gothia**, vertical collaboration in innovation is of high value to many of the firms. In this report, it is shown that collaboration in innovation is important especially through user-producer interaction, while collaboration with research institutes and universities is much less valued. Moreover, the tendencies to collaborate in innovation seem to decline with firm size. Among the roughly 50% of the firms that depend most on their local milieu, the reported collaborations were mainly with suppliers and customers. Therefore, it is reasonable to conclude that vertical collaboration in innovation is quite important in the East Gothia RIS, and these types of collaborative efforts could therefore be argued to have a decisive impact on the functioning of the RIS in East Gothia.

In the **Oslo** KIBS-cluster, in-house competence and vertical linkages seem to be of greatest importance in influencing competitiveness of the firms, while horizontal linkages seem to be of lesser importance. Even if firm's competitiveness is strongly determined by internal competence, clients are generally considered as the most important external factor. Here, the Oslo area serves as the main locality where firms find their collaborates. The most important partners in innovation are located locally, although there are major differences between large firms and SMEs. In the vertical dimension, SMEs are more embedded in localised networks than are larger firms. This notion is further strengthened by the observation that local and national markets are of outmost importance to these firms. In this case SMEs have a larger dependency on the local context than large firms.

Relationships between SMEs and large firms

Above we have discussed relationships between firms in a general manner. At this stage we explicitly discuss the relationships between SMEs and large firms in clusters. These relationships are often of a complex nature, especially in the context of innovations. Sometimes the existence of large firms in the local production environment provides a prerequisite for the growth of the SMEs. This may be the case due to development of supplier relationships between SMEs and larger firms, establishment of spin-offs from larger firms, and due to the fact that larger firms can act as important 'knowledge reservoirs' in the intra-cluster production system. In some cases, the first steps towards a cluster is taken by the establishment of a larger firm, paving the way for a cluster

structure consisting also of SMEs. At the same time, large firms might not have the same incentive as SMEs to take part in intra-cluster collaboration efforts and networking arrangements.

Examples: the cases of Scania, Gothenburg, East Gothia, Jaeren, Aalborg, Horten and Salling

For the functional food firms in **Scania**, collaborative relationships with larger firms, often traditional food processing firms, on regional, national and international level are crucial, as these large firms are the main customers of the (radical) innovations produced by the functional food SMEs. The SMEs are dependent on larger firms to provide resources to finance on-going R&D. In this way, the traditional food companies provide a type of support infrastructure to the SMEs, allowing them to focus on their specialisation, R&D and innovation. In some cases, the collaboration has a distinct local character. But in search for larger markets, one of the SMEs has struck a deal with an international actor. It may be argued that SMEs within such specialised sectors as functional foods, seldom find larger firm partners in their vicinity, not even in a well-developed food cluster such as the one in Scania, but must also be open to establishment of more extensive spatial collaboration patterns.

The biotech firms in the **Gothenburg** biotech cluster are strongly influenced by the presence of one large pharmaceutical firm, AstraZeneca, which employs more than half of the employees within the cluster. Although none of the small biotech firms formally co-operate with AstraZeneca, the multinational plays an essential indirect role for this embryonic cluster of SMEs. Given its recognition as a world-leading firm, it continuously attracts a large pool of well-skilled scientists in the region. Furthermore, some spin-offs can be noted. Previously we have discussed the global character of the learning processes involved in biotech innovation. This global orientation is further reinforced by the particular way of doing business for most of the small biotech firms. Due to costly development and commercialising processes, they team up with larger firms to capitalise on their knowledge or intellectual property or to get access to financial resources, rather than directly releasing concrete products. Interestingly, these larger collaboration firms may be located just about anywhere in the world.

In the **East Gothia** regional innovation system, large firms have traditionally constituted an important part of the regional industrial structure. For example, the origins of the important ICT activity cluster

in the region can be traced back to SAAB Aerospace's efforts to enter the mainframe computer industry in the 1970's, which led to a pronounced competence development at Linköping university and the subsequent decision of Ericsson to locate key R&D facilities in the area. The initial development of the ICT sector in East Gothia was thus driven by large firms, whereas in recent times the growth of the sector is primarily ascribed to high new firm formation rates and a strong university presence. New trends within the ICT sector, as for example vertical disintegration, may create new prerequisites for local SMEs in their relationships with larger firms.

As shown in the **Jaeren** case, the acquirement of local firms by large transitional corporations may bring local co-operation practices under severe stress. New structures of ownership emerged, bringing along new business systems that disrupted local relations. Moreover, the capital allocation system was altered through the introduction of a shareholder value ideology. This seriously affected some of the firms in the Jaeren cluster, weakening the regional cluster structures in for example stable supplier relationships. Clearly, this example shows that relationships between SMEs and larger firms are not just dependent on localised user-supplier interaction effected by developments within the cluster, but can also be severely affected by exogenous developments in terms of firm acquisitions by SMEs and destabilising co-operation structures that change the development paths of a cluster.

In the **Aalborg** cluster, large firms have been extremely important as parent companies to spin-off firms. This spin off dynamic has been one of the most important factors in the constant dynamic and rejuvenation of the Aalborg cluster. Spin off companies have both been founded by firms already inside the cluster, and by firms originating from outside the Aalborg cluster that established new facilities there. Before 1995, mainly local or national firms were parent companies to the new spin offs that were formed. After that, however, MNCs have entered the scene in a decisive way, through investment in existing firms and through acquisitions. By recruiting or hiring experienced personnel, MNCs have stimulated the formation of new spinoffs in the Aalborg cluster. Therefore, it can be argued that the development of spin-off SMEs, deemed very important to the dynamics in the Aalborg cluster, to a large extent is conditioned by the presence of large firms. Here, future entrepreneurs acquire the skills and incentives to start or be a part of setting up new SMEs. A parallel can here be drawn to the Kista cluster, where larger firms also have been vital in creating prerequisites for the development of an SME population. Furthermore, the

downsizing of larger firms in Kista provided strong incentives for the establishment and expansion of SMEs.

In clusters like **Horten** and **Salling**, intense user-producer interaction within the cluster has created dependencies between local supplier SMEs and larger firms in the cluster. This may be a positive attribute concerning the possibilities of localised innovation interaction, but it also increases the vulnerability of the SMEs in the event of exogenous or endogenous shocks or trends effecting the larger firms in the cluster.

In this section, we have seen that the relationships between SMEs and large firms can entail positive as well as negative elements. SMEs are often dependent on larger firms. Trends and developments affecting the large firms in the cluster therefore often spread to the cluster as a whole. However, the relationship between SMEs and large firms does indeed, as shown here, take on extensively different characteristics in different clusters.

Cluster life-cycles: embryonic, stagnant and rejuvenated clusters

The evolution and eventual decline of a cluster can be attributed to a great number of factors, both originating inside (endogenous) and outside (exogenous) the cluster. Technology lock-ins, rapid technology shifts on the world market, changes in corporate structures of leading firms, and macroeconomic shocks are examples of factors that can weaken the competitive advantage of the firms in the cluster. In the long run this may erode the potential of the cluster through detrimental cumulative effects on the cluster's social and economic linkages. In other words, the network structures of the cluster are seriously weakened. However, cluster life cycles are highly difficult to capture into a universal model, since the development is heavily dependent on contingent factors. The possibilities of a cluster to divert from a cluster life cycle are therefore much given by the ability of the actors in the cluster to adapt to an ever-changing environment, inside as well as outside the cluster. As new technologies for example make their way and outdate the older ones, cluster firms are required to adapt to these technologies challenging the old cluster structure.

Strategies of creating or revitalising structures of endogenous character must thus be embedded in wider (national or global) frameworks of co-ordination taking the exogenous forces affecting the development of the cluster into account. Here, we will primarily discuss clusters in very early stages of development (*embryonic clusters*) but also mature or even

declining clusters (*stagnant clusters*). Moreover we distinguish clusters that have seen periods of threatening decline, but prove to be able to adapt to changing circumstances through processes of revitalisation and localised learning, benefiting from both endogenous and exogenous given forces and instruments of change (*rejuvenated clusters*).

Examples: the cases of Gothenburg, Scania, Horten, Jaeren, Aalborg and Kista

The studies on biotech firms in **Gothenburg**, and functional foods firms in Lund, show that these clusters display clear characteristics of *embryonic clusters*. In Gothenburg, the population of firms is very heterogeneous. The majority of firms are SMEs, but some larger companies are also located in the area. Although some of the larger (pharmaceutical) firms have been there for quite some time, the broadened application fields following developments in biotech and related technologies have created considerable expectations concerning the future of the Gothenburg biotech cluster. For some of the firms, it seems that commercialisation is indeed in a lift-off stage, but for many firms the profitability remains yet to be seen. Even though initiatives have been taken, for example towards the strengthening institutional structures in the cluster, the Gothenburg biotech cluster is still in many ways an embryonic one, as intra-cluster collaboration patterns are still weak and in fact to a large extent lacking.

In **Scania**, the functional food firms are embedded both in a traditional food sector and in a highly knowledge intensive development milieu around Lund University. The functional food firms are often seen as vital agents in the re-orientation and revitalisation of the Scanian food cluster. The number of firms in this sector is quite small, the expectations on future growth high, and the co-operation between the firms limited. We thus argue that this cluster displays many of the characteristics of an embryonic cluster, providing possibilities of expansion and bringing new applications of technology into traditional sectors. It can be expected that the R&D as well as the surrounding institutional structure of the innovation system will be strengthened through for example the initiative taken in the “Innovation i Gränsland” project which is part of the Swedish national Vinnväxt programme. The two examples of embryonic clusters in this report are both extremely dependent on state of the art technology and well-functioning connection between the cluster firms. It can be argued that they are in an early phase of their cluster life cycle regarding technology applications as well as in terms of organisational and collaborative structures within the cluster.

Other clusters in this report display more problematic characteristics when it comes to future potential and development prospects. The electronics cluster of **Horten**, has been experiencing a weakening of the loyalty to local suppliers, mainly due to increased international competition and pressure by foreign owners to reduce costs. Relocation of activities has been taking place, outsourcing production to suppliers outside the local cluster. These internationalisation tendencies have been weakening the cluster structure, which in turn raises questions on the future potential of innovative supplier-producer interaction among agents in the cluster. Thereby the potential role of the 'local buzz' and the numerous suppliers and specialist firms may be hampered. In **Jaeren**, the structures underpinning the mechanical engineering cluster has come under severe stress due to endogenous as well as exogenous factors. Much of the story of the mechanical engineering cluster in Jaeren is centred around its network co-operation organisation TESA. The TESA structure has experienced increasing duress due to diverging development paths of individual TESA firms as an outcome of increased specialisation. In the long-run this has resulted in the gradual fragmentation of the TESA system through increased cognitive distances between the firms. In other words, inter-firm collaboration has become increasingly difficult as technologically the common ground within the cluster has decreased. But the Jaeren cluster is not just under stress due to endogenous factors. The emergence of new structures of ownership through various international mergers and acquisitions has disturbed the local monitoring system. As a result of these interacting forces, many members of TESA left the organisation, which today consists only of three firms.

Similar tendencies of hollowing out of localised user-producer interaction patterns can be seen in both Jaeren and Horten, due to cost-efficiency concerns and the search for highly specialised inputs. In both Jaeren and Horten, the stress that is facing the cluster structures poses a number of challenges to the future vitality of the cluster, technological as well as institutional-relational. Therefore the Horten and Jaeren clusters are labelled as typical *stagnant clusters*. But, as we shall see below, also stagnant clusters may be able to alter their development path.

As can be concluded from the case studies of the **Aalborg** wireless telecommunications cluster and the IT-cluster in **Kista**, clusters can under certain circumstances be able to recover after periods of severe stress. In the case of these high-tech clusters, stress factors in the past years can be attributed to the burst of the IT-telecom bubble and the

rapid changes in technology constantly taking place in these sectors. However the hi-tech oriented clusters of Aalborg and Kista seem to have been able to *rejuvenate*, much due to the creation and influx of new SMEs and spinoffs from both university and larger companies in the area. In the case of Aalborg the establishment of MNCs in the cluster have been particularly important incumbents to innovative spinoffs in what can be seen as an on-going cluster revitalisation process. In the case of Kista, a multitude of support organisations has been set up to promote the further development of the cluster, particularly stimulating firm formation and entrepreneurship.

4.4 Social capital and trust: cornerstones for regional collaboration in innovation

After having identified the importance of collaborative innovation for SME competitiveness we now take a closer look at an important underlying factor, social capital. Defined as features of social organization, such as networks, norms, and trust, that facilitate action and cooperation for mutual benefit, social capital can be regarded as one of the prerequisites of a working cluster with dense relationships between actors. Understanding innovation as interactive learning implies that cooperation is necessary for the competitiveness of firms, clusters and regions. Social capital can be rooted in civicness (as in the Third Italy) but can also result from organizational and institutional innovations. The latter is most relevant in this context, as it can be build, while the former type only can be build on. The existence of social capital depends upon the ability of people to associate with each other and the extent to which their shared norms and values allow them to subordinate their individual interests to the larger interests of the community. It secures the conditions that enhance the benefits derived from more tangible investments in physical and human capital.

In many of the studied clusters, public as well as private strategies have been targeted towards creating or enhancing social capital. Especially initiatives on networking arrangements have been particularly successful to boost and secure social capital and thus collaboration in innovation. A prerequisite for this is however that cluster firms recognise the added value in taking part in the arrangements in order to invest time, effort and financial resources. Otherwise, networking efforts will suffer from a severe lack of interest from cluster members. Furthermore, the dynamics in network participation seem to be of a cumulative kind: the more actors

become member, the more want to join. This report includes a range of examples of network initiatives, having an impact on the creation of social capital, ranging from the exemplar, well-developed case in Salling to the seemingly declining network initiatives of Jaeren.

Examples: the cases of Rogaland, Horten, East Gothia and Jaeren

In the **Rogaland** cluster, explicit bottom-up initiatives and investments have been taken with the purpose of setting up specialised intermediate organisations, forums and networks. For example, the Fagforum for Mat og Drikke (FMD, Professional Forum for Food and Drink), was set up as a jointly owned development company by 115 firms and education and R&D institutions in the cluster. Its prime mission is to promote knowledge sharing and competence dissemination, develop centres and networks through forums, bringing parties into contact with another, project development, and project management for research, feasibility and fact-finding studies, and marketing. One of the major strengths of the FMD is the provision of an infrastructure for inter-sectoral information sharing. Also other initiatives that create venues for information sharing, exist in the Rogaland cluster. It is however a lengthy process to get actors to make concrete commitments and investments in organisations for 'mutual benefit', even though actors display a positive attitude towards these kinds of network and development initiatives. Apart from these initiatives, also local and county councils have widened their commitment and allocated means to include the food sector in their development plans. These strategies entail network building, development initiatives, analyses/surveys and lobbying, marketing and image promotion.

Regarding the **Horten** cluster, the Electronic coast network co-operation initiative serves as an arranger of venues, where local actors can meet do discuss issues of common interest. Among other things, the Electronic coast initiative is involved in co-ordination of education initiatives and exchange of labour. Through this initiative several firms in Horten find themselves increasingly embedded in the region. Even though the Horten cluster does not display the same 'institutional thickness' as for example Rogaland, the Horten example shows that also initiatives on smaller scale can be of importance in creating prerequisites for future development of a dense social capital structure.

Another example of a RIS displaying a rich structure of network organisations is **East Gothia**. Many of the network organisations here are targeted towards knowledge and technology transfer, and other types of support mechanisms for entrepreneurial activities. As such, the

multitude of organisations promoting the development of the East Gothia RIS, can be an important factor in the facilitation of the enhancement of social capital, fuelling the further development of firm embeddedness in the East Gothia RIS.

In the **Jaeren** case, the goals of the TESA co-operation (the formal network organisation) enabled the firms to open up to each other, building trust and relational assets. Even if the tendencies of localised co-operation have weakened with the developments in the cluster in recent years, it can be assumed that the TESA structure has served as an important facilitator in the creation of social capital in Jaeren. However, one of the main lessons that can be learnt from the Jaeren case stems from the withdrawal of several companies from the co-operation structure of TESA. Due to increasing specialisation leading to the diminishing of the basis for collaboration, often as a result of foreign direct investment, many firms in the Jaeren cluster did not perceive any value added associated with TESA membership and the majority withdrew from the co-operation structure. This and other developments must be regarded as negative concerning the maintenance of social capital structures previously built up within the Jaeren cluster.

In the **Salling** cluster, the membership of individual firms and entrepreneurs in network organisations is regarded as extremely important. Many of the innovative activities of the Salling cluster are strongly embedded in a local context, having the presence of social capital as a prerequisite. Salling's combination of social conventions and norms is rather unique, and the collectively shared high esteem of high entrepreneurship, craftsmanship, interaction, information-sharing and honesty underpin the preponderance of relations based on trust. Thus, the existence of social capital is critical for the success of this cluster. One important structure reinforcing these inter-firm relations is the Skive carpenter's guild. As a large share of the information circulated within the guild is confined to members only, non-members, find themselves outside the processes creating the unique competitive advantage of the Salling cluster. The high degree of trust between members is a prerequisite for the activities and information sharing within the guild. Here we witness a cumulative interaction, as the interaction between actors taking place within the guild structures reinforces the actual creation of social capital.

4.5 SMEs and the regional knowledge infrastructure

Overview

We argued in the first section that regional, national and international systems of innovation are of complimentary importance for the competitiveness of Nordic SMEs, implying new challenges for RIS. Taking its vantage point in the regional knowledge infrastructure, this section identifies several mechanisms by which the analyzed RIS reinforce SME innovation. Over the past centuries universities have been important strongholds in the generation of knowledge by actively doing research on a wide span of subjects. However, in recent decades, university research has received quite some criticism for residing all too much in 'an ivory tower'.

The core of this criticism comprises a relative under-engagement to perform activities considered relevant to society. As a response, universities have indeed focused increasingly on their 'third mission', i.e. engagement with society at large. This does not mean that traditional fundamental research has completely disappeared, but rather that universities have started collaborating with societal actors such as firms to a greater degree than before in addition to the regular missions of teaching and 'academic' research. This shift had been considerably enhanced by a changing funding regime (based on a greater dependence on external financing as opposed to centralized budget allocation) and competition from applied R&D institutes in the production of knowledge.

In Sweden and Finland, third mission research in the context of society has been most developed while Norway has more recently started. In Denmark, engagement with society is institutionalised by allocating influence and power to representatives from society in the universities' decision-making bodies. Here, In short, we can witness a change to a more entrepreneurial university. Under pressure of political trends of increased devolution, this shift has further resulted in a more pronounced and active involvement of universities in strengthening the regional innovation system. In this section we take a closer look at how universities and the regional knowledge infrastructure at large actually engage with local SMEs in a Nordic context.

Firstly, it is argued that joint research between regional universities and SMEs still yields ambivalent results. This can be explained by taking the institutional context and respective knowledge bases of the firm and university into consideration. A second mechanism by which knowledge

can be transferred from university is by actually establishing a SME through spin-off formation. However, the regional knowledge infrastructure's most important contribution for SME innovativeness that on the whole could be identified in the case studies was the local supply of skilled labor. In general SMEs are highly dependant on the competence and skill level of their own personnel for conducting innovations. Also in collaboration with other knowledge agents, the internal skill level remains an important factor for successful innovations. Finally this section discusses the role of venture capital and science parks.

Joint research with regional universities

The case studies provide evidence that SMEs can benefit from collaborative research with regional-based universities for strengthening their innovative performance. However, the case studies also show that results in this area are somewhat ambivalent and not always living up to expectation. An explanation for this could be that successful cooperation in innovation entails a fine-tuned and difficult to achieve match between academic knowledge and the concrete practice of the SME. Here, the knowledge base of the firm and university needs to be taken into consideration. SMEs drawing on an analytical knowledge base have different knowledge requirements than SMEs drawing on a synthetic knowledge base. While the former emphasize scarce, scientific knowledge and fundamental, basic research the latter would benefit more from applied research and development. In our case studies it seems that university-firm linkages are most frequent and successful for SMEs with an analytical knowledge base, as the East Gothia case most clearly illustrates. But also the institutional context plays an important role in determining the success of joint research with regional universities as it strongly influences how knowledge transfer is shaped and coordinated.

Examples: the cases of East Gothia, Gothenburg, Scania and Oslo

The case of **East Gothia** points out how Linköping University is actively involved in the Industrial Development Centre in Finspång assisting the metal-working cluster with product development. In addition to the university, this initiative is based on a co-operative effort of the municipality and a group of firms. The Industrial Micro-electronics Centre and Institute for Optical Research in Norrköping are other examples which focus on transferring ICT technology from university to SMEs. These are physically located at the university's campus in Norrköping. It is important to note that all these initiatives build on existing engineering competences found within university. Furthermore, such collaborative research does not happen

spontaneously but is institutionalized and facilitated through co-operation between public authorities, universities and firms.

Less coordinated examples of collaborative research can be found in the biotech cluster of **Göteborg** displaying an extraordinary extent of co-production of patents and scientific publications between regional firms and staff at the regional universities. The case in **Scania** shows how path-dependency effects have underpinned current SME-university collaboration. Historical initiatives – such as the Svalöf institute which drew on a tight and successful co-operation between academic scientists at Lund University and the local Scanian farming community in combining pure science and agricultural practice for collaborative research on plant breeding - created a tradition of joint research practice that paved the way for the tight interlinkage between current firm and university research on functional foods.

In contrast to the above success-stories, other findings illustrate that collaborative research between SMEs and regional universities is strikingly lacking. While Linköping University plays an important role for high-tech firms in **East Gothia**, the survey on the innovative behaviour of manufacturing firms in the region sketches a different picture. It is found that the firms hardly co-operate with universities in terms of innovation. The same holds for the KIBS firms in **Oslo**, as the firms tend to rely to a quite marginal extent on the local knowledge infrastructure despite the apparent potential. These apparently contrary findings corroborate our previous argument that collaborative university – SME research may contribute to enhancing the firms' innovativeness under the precondition that the knowledge bases at SMEs and university match. Otherwise, firms show the tendency to find relevant competences with other collaboration actors, possibly outside the region.

SME formation through academic spin-offs

While collaborative research may still show ambivalent results, a more convincing case is made by the university's role in spin-off formation. Spin-offs from university can strengthen a cluster in a twofold way. Firstly, it provides an efficient vehicle to commercialize scientific knowledge generated at university. Secondly it enhances the internal structure of the cluster as such by the formation of new, often highly knowledge intensive firms. This has also been increasingly recognized by universities and policy-makers alike as can be seen by the past and current rise of institutional structures to facilitate academic spin-offs.

Examples: the cases of East-Gothia, Gothenburg and Scania

This is extensively illustrated by the case of **East Gothia** where we can witness a true plethora of programs to develop entrepreneurial culture among academic scientists in order to set up new knowledge-intensive businesses. In particular, science-parks are seen as powerful growth poles (technopoles) to mobilize the human capital found at universities (for a more elaborate discussion of science-parks, see below). But also the cases of biotech and mechanical engineering in **Gothenburg** display a wide array of entrepreneurship enhancing initiatives at university. However, the research on the origin of new technology based firms in Gothenburg shows that 42% span off from private firms while only 10% span off from university. This somewhat disappointing result is however further qualified by an additional 21% of the new technology based firms which were indirect university spin-offs in the sense that they were based on university research, but not established until the founder(s) had gained additional working experience in a private employment. The Gothenburg mechanical industry cluster furthermore shows that the spin-offs subsequently are engrained in the cluster through extensive patterns of local co-operation.

In **Scania**, one of the most important functional food firms is a direct spin-off from Lund University and provides a text-book example of how an academic spin-off successfully launched an innovation originating from scientific knowledge developed at university on the market. Precaution should however be in place with regard to the expectations on cluster enhancement through academic spin-offs, illustrated by the low profitability of new biotech start-ups in Gothenburg. Here, a similarity can be drawn with university – SME research collaboration in the sense that it is a fairly untrodden (and sometimes bumpy) path. Starting up your own business is still an unexplored and risky avenue for many academic scientists and many lessons are still to be learned. Therefore the institutional context and entrepreneurial services provided are of major importance for a successful outcome.

Regional education institutes and the provision of a local, skilled labor pool

A clear outcome of the majority of the performed case studies is the importance of education institutes in the region for the supply of local skilled labour. As a matter of fact, this contribution seems to be the most salient mechanism for upgrading the knowledge base and innovativeness

of SMEs. As is increasingly acknowledged in the literature on clusters and regional innovation systems, people constitute the stickiest carrier of knowledge in firm-based learning.

The extent to which local education institutes can contribute to a skilled local labor force depends strongly on the provision of relevant and high-quality training and education, both with respect to initial graduate education and more upstream training and update courses (i.e. lifelong learning). In some cases, firms and education institutes form agreements to coordinate collaboration in this domain. In the context of coordinated training collaboration, clusters provide a platform to bottom-up initiate and facilitate the matching of education supply and demand while it also renders agglomeration economies in the sense that there exists a concentrated demand for a set of interrelated skills and training.

Examples: the cases of Salling, Rogaland, Horten, and the Finnish Centres of Expertise

In **Salling**, formal education plays a large role in addition to the practical experience acquired by working in the firms. It is argued that the competencies of the Skive Technical School, which is very specialized within wooden furniture production and considered the national quality leader for all its training, leads to an inflow of qualified labor and knowledge to the Salling SMEs, and the system of firms supports the continuous upgrading of the school. Collaboration with local industrialists and the local producer's association for furniture firms provides inspiration, critical inputs, and possibilities for sending out students on trainee work and, as a result, many wood technicians continue working in Salling firms after graduation.

A similar close interaction between educational institutions and firms can be found in the food cluster in **Rogaland**, yet on a broader scale. Here, businesses and trade organizations work closely with both basic and higher education schools providing training in aquaculture, commercial fishing, farming, technical food processing, hotel management and food science to recruit students and organize courses of relevance to the cluster, the curricula of which are sometimes devised jointly by the educational organizations, R&D professionals and regional commerce and industry. Yet, this case also shows that businesses are to some degree obliged to recruit staff with university-levels in technical and economic subjects from national institutes of education outside the region.

In **Horten** we witness a slightly different situation. Higher educated people are mostly recruited from universities and firms in other parts of Norway, and to some extent abroad. Some firms recruit from national university institutes that they co-operate with in R&D projects. A few firms rely on the local university college for recruiting engineers, and make use of a special program to do so. As a matter of fact, this case study identifies a regional mismatch between education and innovation activity in the electronics firms. Until a few years ago, the local university had no education or research activity relevant to the cluster. Through the membership association for electronics and ICT-related firms in the region – Electronic Coast – a bachelor education is started, a master education is being developed and a microelectronic lab including three Ph.D. students has been established in order to upgrade the local competence level as a response to the increasing pressure for local suppliers to introduce process and organizational innovations. On a more aggregated level, the cases of Scania, Oslo, Gothenburg (biotech) and East Gothia point out that the regional universities play a major role in providing qualified labour for local firms. With regard to the **Finnish Centres of Expertise** policy program, the universalisation of the Finnish higher education system is considered a base prerequisite as the availability of personnel resources, sufficient labour availability and knowledge infrastructure for regional innovation would not have been achieved without it. Furthermore, this case illustrates how the upgrading of polytechnics has benefited the innovativeness and competitiveness of particularly SMEs.

The above examples make a strong case for the importance of educational institutes for upgrading the innovativeness of SME clusters by the supply of local human capital. Moreover, the importance of increased collaboration between firms, cluster associations and local educational institutes in order to arrive at a co-production of more tailored intelligent labour needs to be stressed as important means to improve the competence level and competitiveness of SMEs.

The case-studies provide furthermore evidence that the internal competence base of SMEs is of great importance for determining the firms' innovativeness and competitiveness. This does not mean that we reject the argument that innovation takes place in interaction with other organizations. Rather, it comprises the notion that in order to innovate in interaction, firms need a certain knowledge and competence capacity to do so. It can be argued that especially SMEs are highly dependent on the skills and knowledge embedded in the personnel given their small size and resource base. This explains why mobility-schemes are highly

effective as ways to upgrade the knowledge base of SMEs. Moreover, this internal competence base is continuously enhanced by the acquired experience gained by learning-by-doing of the workforce, not the least through user-producer interaction and horizontal collaboration within the cluster. Furthermore, several case studies illustrate how labor mobility between firms in a cluster underpins the transmission of cluster-based knowledge.

Examples: the cases of Oslo, Salling, Scania, and Gothenburg

The study on the knowledge intensive business sector is **Oslo**, corroborates quantitatively the major importance of the competence within the firm as well as the importance of contacts with clients / customers for the firms' innovativeness and competitiveness. This is closely related with the finding that the firms mainly sell products specially designed to end-users. Moreover, the dependence on internal competences can be linked with the finding that knowledge intensive business services are among the sectors that have the largest share of persons with a high education in Norway. Finally, the study reveals that the sector's job mobility within the Oslo area is highest within all sectors.

The **Salling** case reports that the high degree of product, process and organizational innovation within the cluster of firms is underpinned by the know-how and skills contained in the local workforce. The high extent of inter-firm learning is supported by experimentation on the work-floor and through product revisions based upon ideas of employees. In this context it is important to note that the relationship and communication between management and labour is highly non-hierarchical, partly due to some degree of flux between their roles. Given the prominence of artisan knowledge for the individual firms it is rather uncommon to change jobs. The labour market is characterized by very low mobility. However, the external diseconomies for local firms as regards wage levels (one of the highest in Denmark for woodworkers) are compensated by external economies in terms of a highly experienced workforce (one of the highest experience levels in furniture production in Denmark). In some sense the labour market in Salling is quite special. In case an employee loses his or her job, the tradition is that labour stays in the cluster and re-employment is offered in another firm which guarantees that no knowledge is lost. This even holds the potential for new innovations by bringing new knowledge into a firm. An important factor underpinning the local labor market is the high degree of local co-operation between

labor, firms and union yielding flexibility to the functioning of the labor market.

With regard to the biotech clusters in **Scania** (functional foods) and **Gothenburg**, the studies also reveal that the firms largely count on the competences of their employees. The location of the firms close to prestigious universities is therefore linked to the availability of locally skilled labour. These extremely knowledge-intensive firms rely on bringing in personnel that possesses state-of-the-art knowledge. Partly, the same story goes for the electronics cluster in Horten. The innovation activity is largely based upon internal experience and knowledge of individual employees. The experiences are often of a very specific kind and difficult to codify. It is therefore important for the firms that developers stay for a long time and re-use their knowledge from one project or task to another. It is further shown that employees rely much on their personal networks as a source of information when innovating.

Science parks and incubators

A common feature of regional policy initiatives, especially in university regions or other knowledge centres, is the establishment of science parks and incubators, often aimed towards the start-ups and attraction of high-tech industry. Sometimes, these science parks are parts of regionalised national innovation systems, as described in the conceptual clarification. As we have also discussed, these science parks sometimes show a surprisingly weak local co-operative environment, but as we also argue, normally there is richer networking between actors in the regionalised innovation system than in national ones.

Examples: the cases of East Gothia, Gothenburg, Scania and Stockholm

In several of the cases in this report, the role of science parks and incubators are emphasised. In the **East Gothia** RIS, especially concerning the ICT activity cluster, the Mjärdevi Science Park is an important location for high-tech firms in the Linköping area. The science park is located in the vicinity of the university, and it forms an important part in the technological diffusion structure of the East Gothia RIS. The institutional infrastructure of Mjärdevi also includes the Mjärdevi Business Incubator and other organisations, promoting entrepreneurship and the commercialisation of innovations. Other examples of science parks in the East Gothia RIS are Pro Nova Science Park, Norrköping, and the Berzelius Science Park in Linköping, situated on the Health Science and University Hospital Campus. The case of the

Berzelius Science Park is interesting from an SME perspective, as it has a strong focus on the promotion of incubation processes.

Also in the case of the **Gothenburg** biotech cluster, regional initiatives include the establishment of science parks and incubators of importance to the biotech companies. Some companies located in the science parks receive financial support from Chalmers Innovation and A+Science Invest, and business advice is also provided to some firms. In **Scania**, the science park Ideon is located in close spatial proximity to Lund Institute of Technology and Lund University. Also in the **Kista** case, science park and initiatives are prominent features of the development strategies, and in the Finnish case, technology parks are mentioned as being part of the dynamic Helsinki innovation structure.

The cases in this study highlight the potential importance of science parks and incubators as providing an infrastructural dimension in the RIS. However, it is crucial to emphasise the fact that none of the case studies discussed here have been targeted specifically towards analysing the profound effects of incubators and science parks in the development of the RIS. In an SME context, though, the infrastructure provided at the science parks can be of importance to start-up, high-tech SMEs. Even though previous research indicate that collaboration and knowledge diffusion within the Science Parks themselves might not be of great importance to the locational decisions made by firms in science parks, the case studies clearly show the strong connection between science parks and incubators on the one hand, and universities and research institutes on the other. In this context, the conceptual linkages with previous discussed themes in this report on the importance of universities as research centres and providers of a highly specialised labour pool, are apparent.

Modes of financing and venture capital

In discussing innovation in a SME context the financing aspect is often considered as being crucial in the start-up and expansion of firms and the development of innovations. In general, the case studies in this report show a wide range of varieties concerning modes of financing and the role of venture capital.

Examples: the cases of Salling, Oslo and Gothenburg

In the **Salling** furniture cluster, the well-functioning of the financing system is highlighted as being of outmost importance, due to the high turnover of firms, firm expansion, and the experimentation with

innovations. Financing problems are sometimes solved in quite 'unconventional' ways, for example through connections with friends, family or self-financing. In addition, the region has a unique structure of small, independent banks, forming an important part of the financing system for Salling firms. External capital is important for the financing of start-ups.

Also in the **Oslo** case, personal savings form an important part of the financing of the innovation activities of SMEs. Other forms of financing (venture capital and seed money) are probably of greater significance to larger companies than they are to SMEs. In the Oslo case, certain deficiencies vis-à-vis the financing of innovation are identified. Knowledge-based firms are more likely than conventional small firms to face financial constraints. External funding is required if a company is to cope with changing market conditions and technological development, whereas self-financing is the most important source of finance among KIBS. The concentration of venture capital firms in the Oslo region provides potentials to fill the financial gap for small KIBS, thereby also releasing potentials for experienced management and strategic advice to start-ups and SMEs in KIBS.

In the **Gothenburg** biotech cluster, venture capital is of vital importance. 58% of the biotech firms in Gothenburg have raised capital from venture capitalist, and 47% of the capital has been raised from regional venture capitalists. Still, the SMEs in the Gothenburg biotech cluster are in need of more venture capital.

5 Policy Recommendations

5.1 Overview

The following pages provide policy recommendations that are drawn on the basis of the comparative analysis found in the previous chapter. Policy recommendations for the particular case studies can be found in the respective case analyses:

(<http://www.keg.lu.se/forska/projekt/nordic.htm>).

The reader should be aware that the generalization presented here requires caution in connection with its validity to the specific circumstances of SMEs and regions. Therefore, these policy recommendations should not be read as best practice and subsequently applied in an off-the-shelf way. Instead, we assert that policy measures should be drafted in a context-sensitive way. The aim of the following recommendation is thus first and foremost to provide Nordic policy makers with insights, which could be used as a knowledge base for policy making. The policy recommendations follow the same structure as the comparative analysis, i.e:

- SMEs, innovations and innovation systems: a broad perspective
- SMEs, clusters and cluster life cycles
- Social capital and trust: cornerstones for regional collaboration in innovation
- SMEs and the regional knowledge infrastructure.

5.2 SMEs, innovations and innovation systems: a broad perspective

Broad based innovation as the basis for Nordic SME competitiveness

In a knowledge-based globalizing economy, increased competitiveness and innovation go hand in hand. Therefore, measures to boost the competitive strength of SMEs have to primarily target their innovative performance, i.e. the ability to implement new and improved ways of organizing the production and marketing of novel products. Because of the comparatively high factor cost level in the Nordic countries, innovation provides a more promising strategy than competition based on cutting costs. Given the wide nature of innovation activities, a broad-based innovation policy goes beyond and integrates traditional domains

of industrial and economic policy, research and technology policy, education policy and regional development policy. Even though all case studies support this, we refer to the case study on furniture in Salling as the clearest illustration of this recommendation.

Development of a broad-based innovation policy aimed at the general learning ability of SMEs

Because innovation is not just restricted to high-tech clusters of SMEs, the sometimes prevailing view on innovation as mere technological development needs to be re-adjusted. A technological innovation tends to be more successful if it is complemented by changes in the organization of firms. The overall ability to learn is thus central for all types of industries to achieve competitiveness. So, instead of only spearheading measures addressing high-tech SMEs, policy makers on all levels need to take account of the potential of 'ordinary' SMEs to be innovative. This means that more measures need to be taken that target the general learning ability of firms, including technological and organisational learning. Technological learning remains an important aspect for SMEs in their innovative behaviour, in particular for product and process innovation. However, policy-makers should realize that this focus should be backed-up by organizational learning. The case of food production in Rogaland illustrates the above very well.

Development of a systemic perspective on SME innovation support

Small firms tend to experience size-related barriers to innovation. Such barriers can be alleviated by system-oriented and proactive innovation support structures. Regional innovation systems play a key role in this regard by virtue of close proximity and local institutions. Thereby the firms are able to overcome their existing knowledge and competence gaps through processes of learning with actors in the innovation system. This entails a stronger interaction and co-operation in innovation among SMEs (e.g. through user-producer learning) as well as between SMEs and research institutes, universities and colleges. Policy-makers should bear this systemic perspective in mind given the importance of the variety of interlinked actors that offer a broad scope of additional knowledge resources for SMEs. Here, a distinction can be made between peripheral and more central regions close to large urban areas. The conditions for central regions tend to be more positive for SME innovation support through a concentration of knowledge intensive companies, R&D centers and universities in such areas. However, caution is in place as some cases (e.g. wireless communication in Aalborg) show that also peripheral

regions can be able to provide a relevant innovation support. Often this is a result of favorable historical developments of the support structure in line with the development of clusters of SMEs.

Context sensitive upgrading of the regional innovation system

In peripheral regions systemic innovation support often means that the capacities of regional universities and research institutes need to be upgraded so that they can actually respond to the specific knowledge and competence demands of firms in the region. Additionally, closer linkages between the SMEs and knowledge institutes need to be stimulated as a basis for a working regional innovation support system. This can for example be achieved through the establishment of bridging service organizations. In more central regions, already having a well-developed knowledge infrastructure, the focus should primarily be targeted at developing and fostering such linkages.

Measures facilitating access to national and global innovation systems

Our analysis makes however a strong case for a multi-level approach to innovation systems, not only focusing on the regional level. Especially when a firm is mainly involved with innovations based on a analytical (scientific) knowledge base, collaboration mainly entails joint R&D for which the often unique knowledge is concentrated in specific sites across the world. Policy measures could then aim to help the firms in their search for collaboration partners outside the region. In a national context, this can be done by setting up networks of mediating support organizations bringing together SMEs and the national knowledge infrastructure. But also the Nordic perspective offers possibilities for closer international collaboration in offering access to innovation systems outside the region or the nation-state. Moreover, it may sometimes be too costly to build relevant innovation support from scratch. Building regional capacities for innovation support is a long-term project with possibly moderate results in the short run. Notwithstanding this we maintain that innovation processes for firms that depend on a synthetic (engineering) knowledge base to a great extent evolve around the application of existing knowledge or via new combinations of knowledge. Thus, localized user-producer learning is of relatively greater importance than global joint R&D activities. The general point we are making here is that it may be helpful to not, a priori, dismiss policy measures which facilitate SMEs to access innovation support at a wider national or international level. The Horten case can serve as an example of this recommendation.

5.3 SMEs, clusters and cluster life-cycles

Foster horizontal and vertical linkages in a cluster context

Horizontal and vertical collaboration between firms is at the heart of the competitive advantage of clusters. In co-operating vertically, firms collaborate with subcontractors and suppliers, customers and other agents throughout the value chain. Horizontal co-operation, on the other hand, is much different. Here a firm co-operates with other firms or monitors neighbouring firms specialised in more or less the same stage in the value chain. In an SME context, extensive horizontal and vertical collaboration in clusters can be means to compete with large firms, as it offers possibilities to take advantage of economies of scale and scope.

Especially concerning SMEs, policymakers can play a vital role in trying to change firm behaviour towards appreciating the advantages made possible through more intense vertical and horizontal collaboration. In some cases the entrepreneurs themselves realise the benefits of closer interaction, while in other cases firms show a more hesitant attitude towards local co-operation efforts. As closer horizontal and vertical SME interaction can result in realising economies of scale and scope normally only available to larger firms, stimulating such interaction through fine tuned policy measures is a way of improving the efficiency of processes in SMEs and lowering barriers of innovation. Policy strategies towards vertical and horizontal SME co-operation can for example be a way of making it affordable to invest in machinery, technology development schemes or consultancy services normally too expensive for a single SME. For this recommendation, the case of Rogaland displays interesting empirical illustrations.

Policy measures adapted to different stages in the cluster life cycle

In the analysis, three types of stylised cluster life stages have been identified:

- *embryonic clusters*: clusters in very early stages of development
- *stagnant clusters*: mature or even declining clusters
- *rejuvenated clusters*: clusters that have seen periods of threatening decline, but proven able to renew themselves

We argue that clusters in different life stages show very different characteristics in a number of dimensions, such as need of strengthening collaboration networks, technology upgrading and demand on venture

capital. It is crucial that policy measures take this differentiation into account.

Policies directed towards embryonic clusters

In embryonic clusters highly knowledge-intensive SMEs are often central actors. Different kinds of collaboration initiatives between firms often need to be stimulated in order to allow for the cluster dynamics to grow. Furthermore, linkages between the SMEs in the embryonic cluster and universities and research institutes seem to be of extreme importance in order to sustain the growth of the cluster. In addition, the SMEs in contemporary embryonic clusters are often heavily dependent on well functioning local labour markets providing a pool of highly qualified labour. This underlines the importance of an up-to date educational structure, serving not only the economy of yesterday, but perhaps more importantly the economy of tomorrow. Highly illustrative accounts of embryonic clusters are found in the case studies on functional food in Scania and biotechnology in Gothenburg.

Policies directed towards stagnant clusters

Symptomatic for stagnant clusters are outdated collaboration structures and locked-in technological development paths. In this context, policy makers can learn important lessons from the experiences of rejuvenated clusters. The stimulation of entrepreneurship and new firm start-ups contributes to revitalizing old structures and bringing new technology and knowledge into the cluster. In this, universities and large firms can play an important function as seedbeds. Policy makers can contribute in the revitalization process by providing institutional support to new firms and entrepreneurs but also by measures aimed at upgrading the knowledge base of the stagnant cluster (e.g. through education policy). Here, the case of electronics in Horten should yield valuable empirical insights.

5.4 Social capital and trust: cornerstones for regional collaboration in innovation

More research on social capital as a prerequisite for collaborative SME innovation

One of the most important findings of this research has been that social capital can be regarded as a prerequisite for a working regional innovation system and cluster with dense co-operation between the

actors. Social capital is defined as features of social organisation, such as networks, norms, and trust, that facilitate action and cooperation for mutual benefit. In a cluster or regional innovation system context, network organisation membership of firm and non-firm actors forms a concrete approach in the process of social capital building. This research has shown that network organisations are indeed integral and essential parts of Nordic cluster structures that provide a strong mechanism by which firms become embedded in the region. Yet, the role of social capital in a cluster context is still relatively weakly understood and more research in this field is certainly needed. The Salling furniture cluster provides an exemplar case of how social capital constitutes the cornerstone for its collective performance.

Social capital through networking arrangements

Cluster firms, especially SMEs with limited management resources, have to perceive the added value for taking part in network arrangements in order to invest time and money. Sometimes this involves a conflict between individual short term firm interest and the collective long-term interest, since the short-term benefits are rather intangible and difficult to measure in quantitative terms. Here, policy support may be needed to stimulate network membership. However, once a (cluster) network organisation is established and has achieved sufficient critical mass, it should be able to sustain itself through cumulative reinforcement: the more actors that join in, the more attractive and valuable membership becomes. Here, the case of Jaeren serves as a good example of how the members need to perceive added value in network membership in order for the network to sustain.

Social capital through participatory, bottom-up policy initiatives

Apart from networking arrangements, another way by which social capital can be built is through participatory, bottom-up policy making. The existence of social capital depends on the ability of people to associate with each other and the extent to which their shared norms and values allow them to subordinate their individual interests to the larger interests of the community. Through frequent meetings and collaboration between SMEs, large firms, universities, research centres and the public sector in jointly designing regional development strategies, conditions can be created conducive to trust and social capital creation. Such policy initiatives, if successful, thus have a twofold effect. Not only do they improve the quality of the policy itself as it is sensitive to the real demands of the actors in the region, they also provide a multiplier effect

in the sense that it stimulates collaboration and enriches social capital both inside and outside the policy arena. The Finnish Centres of Expertise provide an excellent example of this.

5.5 SMEs and the regional knowledge infrastructure

Facilitate broad learning between SMEs and regional knowledge institutes (universities and R&D institutes)

This research found that the results of joint research between SMEs and the regional knowledge infrastructure or technology transfer have thus far shown positive but somewhat modest results. Formal collaborative research between regional R&D institutes and universities on the one hand and SMEs on the other is still a relatively new phenomenon. Barriers to a more efficient knowledge transfer are in many cases ascribed to ‘cultural differences’. It can therefore be argued that apart from technological learning, the actors are also involved in an ongoing effort to learn to actually co-operate. It is important to stimulate such broad interactive learning processes. Furthermore the partners need to see real, tangible results in order to gain confidence about the collaboration. Thereby the perceived cultural barriers between the partners can be gradually diminished. Given the small resource base of SMEs such policy makers should support firms to find the right partner (department) within the university or R&D institute dependant on the needs they have. Furthermore they could perform a brokering role in optimizing the outcome for all partners involved. This entails matching the knowledge base of universities with the concrete practice of SMEs. Such policy institutions could co-operate with cluster organizations in order to align the demand and supply in terms of relevant knowledge. Good examples of SME-university collaboration initiatives can be found in the case study on East Gothia.

Provide ‘real’ support for entrepreneurship at university and research institutes

In a learning economy universities and research institutes hold major reservoirs of knowledge. Policy should promote entrepreneurship and firm formation among researchers in order for the ‘locked’ scientific knowledge to be more actively used in a societal context. However, researchers often lack the managerial skills and knowledge to run a business. Policy schemes that support entrepreneurship financially are often already in place. They need to be complemented by support structures that help new entrepreneurs from the research sphere to make

the behavioral switch to a business environment. This entails the provision of management education and support. The case study on Kista is exemplary in this respect.

Acknowledgement of the role of education for SME innovation policy

A central finding of this study is the importance of higher education institutes in the region for the *supply of local skilled labour* as an indirect source of SME competitiveness. The educational role of universities and colleges appears to be the relatively strongest and most regionally embedded role of universities in the regional innovation system. SMEs are highly dependant on the skill level of their workforce. In contrast to large firms, the absolute number of skilled workers is however limited. Also when innovating in interaction with other actors, firms need a certain knowledge / competence capacity to do so. For SMEs such a capacity is heavily embedded and condensed in the *skills of the personnel*. Knowledge is made valuable by people actually utilising it. In this context, the recent policy initiatives in the field of education implemented to upgrade the knowledge base of the electronics firms in Horten needs to be mentioned.

Concrete measures to promote the alignment of training needs and demand

In order to provide SMEs with a skilled local labour force that enhances their innovative capacity, policy measures should be taken that particularly target education that relates to the skills and knowledge which SMEs need. By setting up workshops, courses, training programs at the regional educational institutes in line with the activity base of the SMEs a more specialised and dedicated workforce can be accomplished. However, policy-makers need to invite business (SMEs) to speak out about their needs (e.g. by voice of cluster or sector organisations) and can fulfil a mediating role to bring the educational and private sector together. Furthermore, public policy should stimulate the availability of traineeships in SMEs as part of the curriculum of students. Also job rotation and mobility schemes between SMEs and educational institutes offers a concrete opportunity to bring these actors closer together.

Measures aimed at stimulating life-long learning

In a learning economy, initial education more than ever needs to be complemented by on-going training of employees for the firms to remain competitive. Given their limited resource base, SME may tend to under-

prioritise this issue. Therefore policy measures should be taken that stimulate SME employees to follow updating and refreshment courses. Cluster network and business organisations can contribute in providing a platform and critical mass to collectively set up such initiatives.

Measures aimed at broad incubator support for starting high-tech SMEs

The infrastructure provided by science parks plays a facilitative role to the start-up of knowledge intensive, mainly high-tech, SMEs. This tends to be of more importance than another expected outcome of science parks: increased collaboration and knowledge diffusion between universities and firms. Notwithstanding this, the close proximity to universities remains essential as many high-tech SME start-ups originate from former university employees that wish to stay in the region. Thus, for SMEs incubator services tend to be the most prominent feature of science parks. Policy makers should acknowledge that the function of science parks is mainly conducive to firm start-up from university while the envisaged closer collaboration with universities should not be exaggerated. Furthermore, policy should not only focus on the hard infrastructure (e.g. office-space) and providing start-up capital for business establishment. Complementary to this, tools need to be developed to assist young high-tech SMEs in sustaining their business through the course of the firm's life cycle (e.g. through management support and provision of growth capital). This point is clearly illustrated in the Kista study.

More research on the role of venture capital for innovation in SMEs

This study demonstrates that SMEs in the Nordic countries finance their business and innovation activities in a great variety of ways. This can range from hi-tech industries with great need (and sometimes use) of venture capital to low-tech industries more relying on self-financing and established regional bank structures. Therefore it is difficult to draw general conclusions in this respect. However, in a learning economy venture capital is a promising avenue of financial support as it also brings along knowledge and competence. This study concludes that the role of venture capital for high-tech SMEs is however under-researched and is in need of more investigation.

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