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The Role of Regional Innovation Systems in a Globalizing Economy: Comparing Knowledge Bases and Institutional Frameworks in Nordic Clusters

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Abstract

In order to advance the understanding of which types of regional innovation system represent effective innovation support for what kinds of industry in different regions analyses must be contextualized by reference to the actual knowledge base of various industries as well as to the regional and national institutional framework, which strongly shape the innovation processes of firms. Of special importance is the linkage between the larger institutional frameworks of the national innovation and business systems, and the character of regional innovation systems. In making the arguments about a general correspondence between the macro-institutional characteristics of the economy and the dominant form and character of its regional innovation systems a link is provided to the literature on 'varieties of capitalism' and national business systems.

The Role of Regional Innovation Systems in a Globalising Economy: Comparing Knowledge Bases and Institutional Frameworks of Nordic Clusters

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INTRODUCTION

Over the past two decades social scientist and policy makers have been paying more and more attention to regions as designated sites of innovation and competitiveness in the globalising economy. The popularity of this argument can be traced back to various empirical studies of regional success-stories such as the rapid economic growth of networked SMEs in industrial districts in the ‘Third Italy’ (Asheim 2000), the exemplar industrial system of Silicon Valley (Saxenian 1994) as well as other examples of successful regional clustering in most developed as well as developing economies (Porter 1990). These studies all draw on the common rationale that territorial agglomeration provides the best context for an innovation based learning economy promoting localised learning and endogenous regional economic development (Asheim 2002).

In this discourse, two concepts belonging to the territorial innovation theory family (Moulaert and Sekia 2003) demonstrate particular resonance: clusters and regional innovation systems. Even though both concepts are closely related, they should not be conflated. Therefore we argue for an analytical distinction not the least against the background of a rising popularity of both concepts in policy and consultancy circles. It can in fact be observed that many regions have been treated with off-the-shelf, ‘best-practice’ cluster or regional innovation system solutions drawn “from the experience of successful regions or some expert manual” (Amin 1999: 371) without due regard for its specific context and circumstances. This paper seeks to take up the issue of contextualisation along two tracks. From a bottom-up perspective it firstly discusses the linkage between regional innovation systems and clusters on the basis of the cluster’s knowledge base and secondly, from a top-down perspective, it positions regional innovation systems in their wider national frame.

Section 2 introduces the notion of the learning economy as well as the two main contextualisation tracks: industrial knowledge base and institutional frameworks. Section 3 elaborates on the two main concepts, clusters and regional innovation systems. Section 4 provides the empirical illustrations from a Nordic comparative project on SMEs and regional innovation systems. Finally, conclusions and implications for further research are given in section 5.

PROVIDING CONTEXT: THE LEARNING ECONOMY, INDUSTRIAL KNOWLEDGE BASES AND INSTITUTIONAL SETTINGS

Both the knowledge-based as well as learning economy rationale argue that in the globalising economy knowledge is the most strategic resource and learning the most fundamental activity for competitiveness (Lundvall 1992; OECD 1996). However, in academic as well as policy oriented discourses these two concepts have from time to time taken on different meanings with potential importance for the theoretical understanding of the contemporary economy as well as for policy implications. Lundvall has always preferred to talk about the contemporary global economy as a ‘learning economy’, while the OECD (at least the economic sections), being strongly influenced by the US, has instead more often used ‘the knowledge-based’ economy. The difference between the two can basically be traced back to the threefold taxonomy of high-, medium- and low-tech industries as suggested by the OECD (1986). This taxonomy reflects the R&D intensity between industries with those spending more than five percent of turnover being classified as high-tech. Though the initial discussion was carefully launched, offering many necessary qualifications, it still seems that the high-tech fascination has taken on a life of its own, equating R&D intensity with innovation at large (Hirsch-Kreinsen et al. 2003). Because of its more inclusive notion of innovation we prefer to argue in terms of the learning economy rather than the more exclusive and high-tech focused knowledge-based economy. Thus we follow Cooke et al. (2003) in their broad definition of innovation as the transformation of knowledge into novel wealth-creating technologies, products and services through processes of learning and searching.

In a learning economy innovation is basically understood as an interactive learning process, which is socially and territorially embedded and culturally and institutionally contextualized (Lundvall 1992). This conceptualization of innovation means an extension of the range of branches, firm-sizes and regions that can be viewed as innovative, also to include traditional, non R&D-intensive branches (e.g. the importance of design in making furniture manufactures competitive and moving them up the value-added chain). An important implication of this broad perspective on innovation is to re-establish the focus on the "enormous untapped growth potential that could be mobilized to solve social and economic problems" if the necessary "institutional reforms and organizational change that promote learning processes" were implemented (Lundvall 2004: 1). This implies that the introduction of advanced technologies has to be accompanied by organizational change and competence-building among employees in order to become successful. Furthermore, the outsourcing to subcontractors and suppliers within a production system as a result of the development from vertical integration to disintegration of production is accompanied by a transition from an internal knowledge base in specific industries to a distributed knowledge base of firms (Smith 2000). Knowledge flows within a distributed knowledge base can take place between industries with very different degrees of R&D-intensity further weakening the analytical and substantial distinction between high-tech and low-tech industries. (e.g. when food and beverage firms produce functional food based on inputs from biotech firms).

Despite the generic trend towards increased diversity and interdependence in the knowledge process, we argue that innovation process of firms and industries is depending on their specific knowledge base (Asheim and Gertler forthcoming). Here we will distinguish between two (ideal) 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 from the globalising economy. Table 1 provides a summary of some important differences.

<table 1>

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.

Lam (2000) underlines that learning and innovation cannot be separated from broader societal contexts when analysing the links between knowledge types, organisational forms and societal institutions in order to meet the needs of specific industries in particular with respect to learning and the creation of knowledge in support of innovations. Soskice (1999) argues that different national institutional frameworks support different forms of economic activity, i.e. that coordinated market economies (e.g. the Nordic and (continental) West-European welfare states) have their competitive advantage in ´diversified quality production´ (Streeck 1992), based on problem solving, engineering based knowledge developed through interactive learning and accumulated collectively in the workforce (e.g. the machine tool industry), while liberal market economies (e.g. the US and UK) are most competitive in production relying on scientific based knowledge, i.e. industries characterised by a high rate of change through radical innovations (e.g. IT, defence technology and advanced producer services). Following Soskice, the main determinants of coordinated market economies are the degree of non-market coordination and cooperation which exists inside the business sphere and between private and public actors, the degree to which labour remains 'incorporated' as well as the ability of the financial system to supply long term finance (Soskice 1999). This represents a situation in direct conflict with a preference for unilateral control over work processes, generated by certain finance and governance systems found in liberal market economies, where competitive strength is based on the institutional freedom as well as financial incentives to continuously restructure production systems in light of new market opportunities (Gilpin 1996). While coordinated market economies on the macro level support co-operative, long-term and consensus-based relations between private as well as public actors, liberal market economies inhibit the development of these relations but instead offer the opportunity to quickly adjust the formal structure to new requirements using temporary organisations frequently.

Such differences - due to the impact of the specific modes of organisation of important societal institutions such as the market, the education system, the labour market, the financial system, and the role of the state - both contribute to the formation of divergent 'business systems' (Whitley 1999) and constitute the institutional context within which different organisational forms with different mechanisms for learning, knowledge creation and knowledge appropriation have evolved. Through its emphasis on institutional complementarities the varieties of capitalism approach focuses on dynamic ensembles of mutually reinforcing sets of institutions rather than isolating individual forms and their impact. As such it pieces together consistent configurations of institutions and the implications for innovative performance (Nooteboom 2000). However, despite the emphasis on institutional complementarities, it takes predominantly institutions at the national level into consideration leaving "the multi-scaled set of institutional forms" (Martin 2000: 89) unaddressed.

In a learning economy, which indeed also is a knowledge-based economy, competitive advantage is based on exploitation of unique competencies and resources. A firm or a region competes on the basis of what they have which is unique in relation to their competitors. A strategic perspective in the contemporary global economy is, thus, how to develop such unique competencies and resources in order to foster competitiveness based on competitive advantage (Porter 1990). Hall and Soskice (2001) partly critisize this position by arguing that the theory of competitive advantage identifies factors that improve the performance of any economy, while not taking sufficiently its comparative advantage into account. This refers to the aforementioned idea that the distinct institutional structure of a political economy favour specific types of firm activities. Moreover they contend that such institutional structures are difficult to change. The institutional landscape invoked here can in turn be criticized for being overly inert and inherited (Peck 2003). It is generally recognised that the theory of competitive advantage is more dynamic than the theory of comperative advantage, and, thus, can be more easily influenced by innovation policies and supporting regulatory and institutional frameworks. In this way innovation plays a central role in attaining and sustaining competitive advantage.

To understand the difference between competitive and comparative advantage is it important to acknowledge the multiple and interrelated layers by which institutions tend to work (Rogers Hollingsworth 2000). At the high end of the hierarchy of the institutional setting of a society we find deeply embedded norms and values which are more permanent and durable. Changes at this level are highly likely to influence the lower levels of the institutional spheres which are more open and susceptible to change. While the theory of comparative advantage stresses the persistence of institutional structures, the theory of competitive advantage allows to a greater extent for institutional change. In order to understand both the competitive and comparative advantages of a region it is important to recognize the duality of institutional frameworks by interpreting them as ”enabling constraints” (Nooteboom 2000: 94).

REGIONAL INNOVATION SYSTEMS AND CLUSTERS: DIFFERENCES AND CONNECTIONS

An important tool for analysing regional performance in the learning economy is the concept of regional innovation system (RIS) which appeared in the early 1990s (Cooke 1992; 1998; 2001), a few years after Chris Freeman first used the national innovation system concept – originally developed by Bengt-Åke Lundvall - in his analysis of Japan’s blooming economy (Freeman 1987). 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 framework. This dynamic and complex interaction constitutes what is commonly labelled systems of innovation (Edquist 1997), i.e. systems understood as interaction networks (Kaufmann and Tödtling 2001). A set of variations on this approach have been developed over time, either taking territories as their point of departure (national and regional) or specific sectors or technologies (Fagerberg et al. forthcoming).

The National Innovation Systems (NIS) approach highlights the importance of interactive learning and the role of nation-based institutions in explaining the difference in innovation performance and hence, economic growth, across various countries. Regions are nonetheless seen as important bases of economic coordination and governance at the meso-level between the national and the local (cluster or firms): “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: 39).

To a large extent the 'system' dimension in RIS was inspired by this literature. In case the following two subsystems of actors are systematically engaged in interactive learning (Cooke et al. 1998) it can be argued that a regional innovation system is in place:

- The regional production structure or knowledge exploitation subsystem which consists mainly of firms, especially where these display clustering tendencies.
- The regional supportive infrastructure or knowledge generation subsystem which consists of public and private research laboratories, universities and colleges, technology transfer agencies, vocational training organisations, etc.

As it refers to 'regional', it is geographically defined by the boundaries of the region: i.e. an administrative division of a country yet above the local or municipal level (Cooke and Leydesdorff forthcoming). Nonetheless, the level of regional administration can differ quite a lot across various countries. Furthermore, regional governance is expressed in both private representative organisations such as branches of industry associations and chambers of commerce, and public organisations such as universities, polytechnics and regional ministries with devolved powers concerning enterprise and innovation support, particularly for SMEs. The regional innovation system approach does not only exist as a framework for studying economic and innovative performance but it is also in use as a concrete tool for policy-makers to systemically enhance localised learning processes to secure regional innovativeness in practice (which in turn influences the functioning of the regional innovation system as such) (Asheim et al. 2003a).

Clusters and RIS are indeed closely related. In order to delineate the concepts we argue that it is essential to acknowledge sector specificity and a high density of functionally related firms as necessary cluster conditions. Therefore we prefer Isaksen and Hauge's (2002: 14) definition: "a concentration of interdependent firms within the same or adjacent industrial sectors in a small geographic area", rather than the traditional Porterian which conflates both concepts[1]. Through processes of localised learning clustered firms enjoy advantages in terms of innovation performance. A RIS can in principle stretch across several sectors in the regional economy and is more lenient in terms of necessary conditions. A RIS is in place as soon as there are firms and knowledge organisations that interact systematically on the regional level. This means that clusters and RIS may co-exist in the same territory. The regional innovation system may in fact contain several clusters.

Furthermore, research has revealed that the regional level is neither always nor even normally sufficient for firms in a cluster to stay innovative and competitive (Isaksen 1999). Under pressure of processes of globalisation the learning process becomes increasingly inserted into various forms of networks and innovation systems (at regional, national and international levels). The continuous importance of the regional level is however confirmed by results from a European comparative cluster survey (Isaksen forthcoming), which shows that regional resources and collaboration are of major importance in stimulating economic activity in the clusters. Nonetheless, the survey found an increased presence of MNCs in many clusters, and also that firms in the clusters increasingly source major components and perform assembly manufacturing

[1] "A geographic concentration of interconnected companies, specialised 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" (Porter 2000: 253).

outside of the clusters (Isaksen forthcoming). Also Tödtling et al. (forthcoming) found support for clustering, because of the importance of social interaction, trust and local institutions. Yet they also note that both local and distant networks are often needed for successful cooperative projects, in particular for projects of innovation and product development when it is usually necessary to combine both local and non-local skills and competences in order to go beyond the limits of the region (see also Asheim and Herstad 2003; Bathelt et al. 2004; Cooke et al. 2000).

A central point that this paper seeks to put forward is that clusters drawing on a predominantly synthetic knowledge base are more loosely coupled with the regional innovation system in comparison to clusters which draw on a predominantly analytic knowledge base. The latter case can thus be typified as an *integrated* cluster-RIS configuration. In the former case the regional innovation system is contingently supportive to innovation in the cluster yet they do not form an integrated whole and can thus be typified as an *auxiliary* cluster-RIS configuration. It needs to be noted that this proposition does not exclude the importance of non-regional knowledge linkages. It primarily entails the argument that in auxiliary cluster-regional innovation system configurations, 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 an integrated regional innovation system-cluster configuration, 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 (e.g. (technical) universities). Below the difference between an auxiliary and integrated cluster-RIS configuration is illustrated on the basis of a comparative analysis of five clusters in three Nordic countries: Denmark, Sweden and Norway.

First, it is however important to realize that in a general institutional framework Sweden, Norway and Denmark are coordinated market economies (Hall and Soskice 2000) in contrast to the liberal market economies found in the UK and US. On an overall level this means that firms tend to rely more on strategic interaction among firms and other actors. In an innovation system context the prime mode of firm conduct is ‘voice’ as opposed to the ‘exit’ mode typical for liberal market economies (Nooteboom 2000). Systemic relationships between the production structure and the knowledge structure embedded in networking governance structures are therefore characteristic for innovation systems in the Nordic countries. In comparison, exit based innovation systems lack these strong systemic elements and are to a greater extent based on individual entrepreneurialism, flexibility and venture capital. In a comparative study between the Danish and Swedish system of innovation Edquist and Lundvall (1993) confirm Hall and Soskice’s (2000) argument that both Sweden and Denmark show modest results in terms of radical innovation while being better in incremental innovation. Nonetheless, they also distinguished a significant difference between the Swedish and Danish innovation system.

> [In Denmark] “the survival of small scale and artisan-like production has fostered a kind of corporatism, very different from the Swedish. Small, independent entrepreneurs in Denmark will often be quite negative to central

> union power, but at the same time, often willing to cooperate, locally with their workers and their representatives. […] This small-scale corporatist model often involving a flexible use of reasonably advanced production equipment and a continuous development of incremental product innovations has its strength in flexible adaptation." (Edquist and Lundvall 1993: 275).

In contrast, the authors describe the Swedish innovation system as comparatively more advanced in process innovation against the backdrop of a dominating position of large firms and heavy investments in R&D on a national level. On a general level Denmark tends to fit best with the institutional features of a 'coordinated industrial district' while Sweden would belong to the 'collaborative' national business system (Whitley 2000: 60). The Norwegian general framework seems to be quite similar to the coordinated industrial district system of Denmark due to the large amount of SMEs. However, a key difference stands out through the national specialization in process industries which follows from the importance of petroleum for the Norwegian economy.

These rather static macro-level tendencies represent the comparative advantages of nations and as regions are by definition part of the national system, they also influence innovation processes on the regional level. However, this top-down perspective does not take full account of the competitive advantage of firms on the regional level which underscores to a greater extent the exploitation of unique competencies and resources through processes of localised learning as discussed below.

COMPARISON OF NORDIC CLUSTERS

Empirically the analysis builds on a set of studies that have been conducted on various regional clusters / regional innovation systems in three Nordic countries[2]:

- Denmark: the furniture cluster of Salling and the wireless communication cluster of North Jutland
- Sweden: the functional food 'cluster' of Scania
- Norway: the Rogaland food cluster and the Horten electronic cluster

On the issue of method Cooke (1994: 12) argues that one of the distinct advantages of the RIS approach is that it allows for a systematic comparison of innovation activities across various regions. "Conducting such comparable studies can lead to identification of some functional equivalents for specific as well as generic problems within the innovation process". However, various other researchers remain critical and argue that the rise of the 'Silicon Valley fever' (Benneworth and Hardy 2003) has confined much work to text-book cases in high-tech sectors (Doloreux 2002). It is argued that more attention should be paid to applying the approach on other regions than the stereotypical 'happy few' and, more importantly, theory must be informed by the lessons drawn from such ordinary regions. Reflecting on the applicability of the concept Kaufmann and Tödtling (2000) question whether regional innovation systems can only be found in exemplar regions or also in less ideal situations. Their comparative study of old traditional industrial regions shows that the concept does not necessarily embrace extraordinary regions only but allows for utilisation in ordinary regions as well. The scope of this paper does not allow for detailed analyses of the individual cases[3]. Instead we focus on their most important characteristics needed to illustrate the argument made

[2] These studies were carried out through the common research project 'Nordic SMEs and Regional Innovation Systems' financed by the Nordic Industrial Fund (currently Nordic Innovation Centre).
[3] For this, see Asheim et al. (2003b).

previously on the loose respective tight coupling between clusters and regional innovation systems dependent on the respective industrial knowledge base.

Over the past decades the furniture producing sector in *Salling*[4] has demonstrated considerable economic growth despite high factor costs. Between 1972 and 1992 employment in the cluster tripled (while overall employment in Denmark decreased) and the number of firms grew with approximately 80%. In 1996, 54 firms employed 2388 employees of which the majority can be classified as SMEs (Lorenzen 2003). This remarkable performance is ascribed to the strong ability of the cluster to collectively penetrate new markets, brand products and develop new designs. This high level of low-tech innovativeness is in turn underpinned by a combination of stable and at the same time flexible inter-firm relationships held together by a high level of trust and shared norms and conventions. The high-tech wireless communication cluster in *North Jutland*[5] consists of roughly 35 firms employing around 3220 people. In terms of firm size the cluster is composed of both SMEs as well as establishments of major multinationals. In 1997, the private sector, Aalborg University and the science-park NOVI established the formal cluster association NorCOM[6] indicating successful cooperation between the various actors (Dalum et al. 2002).

The case for Sweden, functional foods in *Scania*[7], is situated in a region which is by tradition an important national centre for agricultural production hosting some of the

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[4] The case of Salling in Denmark draws predominantly on the work of Mark Lorenzen at Copenhagen Business School
[5] This case draws on studies carried out by Michael Dahl, Christian Pedersen and Bent Dalum at Aalborg University
[6] http://www.norcom.dk
[7] This case draws for the most part on work by Gustav Holmberg at Lund University

country's largest food processing industries. Previous empirical research identifies the food sector as well as the life science sector as constituting the two internationally competitive clusters in Scania (Nilsson et al. 2002). Functional foods[8] are regarded as an area of high future growth and innovation in a sector which is traditionally considered as having low growth and low levels of innovation. Against this background several small, R&D intensive companies dedicated to functional food have emerged around the University of Lund. Furthermore these companies work together with the traditional large food companies for the production and marketing of functional foods as well as with regional research groups and organisations in terms of scientific research. It would go too far to consider this a full-fletched cluster but it can be argued that a highly innovative and knowledge intensive embryonic cluster is taking shape.

The cases for Norway are constituted by the *Rogaland*[9] food cluster and the *Horten*[10] electronics cluster. Rogaland is a leading production area for food in Norway. Onsager and Aasen (2003) distinguish three partially differentiated, partially integrated subsystems: agrofood production, seafood production and life-stock production. Even though these subsystems are internally differentiated each exploiting separate raw materials, production technologies and end markets, functional connections and interrelations are in place across the subsystem with regard to subcontracting, common customers and support organisations (R&D, training and professional forums). Given this differentiation questions can be raised whether one can consider this a true cluster.

[8] i.e. artificially developed food with added ingredients that demonstrate scientific evidence of positive health-related effects

[9] This case draws mainly on a study carried out by Knut Onsager and Berit Aasen et the Norwegian Institute for Urban and Regional Development (NIBR).

[10] This case draws mainly on a study carried out by Arne Isaksen at Agder University College.

Notwithstanding this, Rogaland makes an interesting case because of the geographical concentration of companies and support organisation constituting an “agglomerated sector environment” (Onsager 1999) that displays a high degree of local collaboration in terms of innovation. Finally, the case of Horten can rightfully be defined as a real yet small cluster, hosting approximately 25 firms and 1,900 employees in the electronics sector (Isaksen 2003; Asheim and Isaksen 2002). The cluster contains a few large enterprises but is dominated by SMEs. The motive powers in the local electronics industry are the large system houses and OEM-suppliers (Original Equipment Manufacturers). These mainly collaborate with national and international research organisations, universities and customers when innovating. Still, one can speak of localised learning through the movement and personal networks of individuals between different Horten firms. However, a third group of firms in the cluster, the local subcontractors display clear regional linkages by delivering for the system houses and OEM-suppliers in Horten. As specialised producers of components and software they play a significant role in co-innovation processes with their customers in connection with transferring prototypes into effective industrial production as well as joint problem solving.

In this section we analyse the industrial knowledge base of the respective clusters in relation to the loose versus tight coupling between cluster and regional innovation system. Table 2 summarizes the result of this analysis.

<Table 2 here>

When analyzing the case study conducted by Lorenzen (2003) the characteristic knowledge base of the furniture cluster in Salling can be classified as synthetic. In terms of technological product innovations the Salling firms are mainly designing varieties with regard to for example style, materials and colours based on the existing product-line. Totally new products types and designs are typically introduced once a year. Process innovations necessarily follow such new product designs. The shift from hardwood to other materials, notably plywood, is considered as the most dramatic shift that the cluster witnessed. The synthetic nature of the knowledge base is further illustrated through the way that the companies innovate internally: experimentation at the shop floor and product revision based upon employees' ideas. The most important innovation mechanism are however local inter-firm relations. These appear to be highly conducive to both user-producer innovation as well as horizontal networks. In terms of direct knowledge flows and learning processes the Salling cluster appears to be nearly exclusively firm-based with few connections outside the cluster or other knowledge organisations. Yet indirectly two local organisations are significant for the innovative performance of the cluster. Firstly, the skills needed by the workforce stem very often from education at the local technical school which is considered as highly specialised in furniture production. Secondly, another important organisation for the cluster is the local cabinetmakers' guild. The guild provides a crucial venue for the firms to exchange information and coordinate inter-firm relationships. However, processes of interactive learning occur nearly exclusively between firms in the furniture production structure as such.

The Rogaland regional food cluster provides a somewhat more complex picture even though the general argument holds: the linkage between the cluster and the regional innovation systems can be characterized as auxiliary in the light of the predominantly synthetic knowledge base of the regional food industry. As Onsager and Aasen (2003) show, Rogaland hosts important R&D bodies involved in innovation activities with the cluster companies. An example is 'Nordconserv' (the Norwegian Institute for Fish Processing and Preservation Technology) which serves as an important centre of expertise for regional companies in adjustment and development processes of production structures. The institute is renowned for its emphasis on hands-on research of relevance to industry. However, these R&D bodies are often divisions of wider national organisations. This can be seen as characteristic for the Norwegian situation where public R&D programmes have a long tradition of implementing R&D programmes at the national level even though recent policy measures appear to be moving towards stronger regionalisation tendencies. As such, the cluster does not appear to have an exclusive embeddedness in the regional innovation system. Learning and knowledge transmission "depend extensively on an ability to make use of knowledge resources from many different players, centres and levels" (Onsager and Aasen, 2003: 28).

The above example of low-tech innovations can be contrasted with the high-tech cluster of Northern Jutland and the embryonic functional food cluster in Scania. These cases are prime examples of analytic knowledge base clusters for which the regional knowledge infrastructure plays a crucial role. The historical overview of the development of the wireless communication cluster in North Jutland provided in Dalum et al. (2002) and Dalum et al. (1999) shows clearly how the presence of Aalborg university and the NOVI science park have been essential requisites for the cluster's growth. This interdependence has even been formalised through the NorCOM cluster association founded in 1997. Ever since the university's establishment in 1974 the regional deliverance of skilled engineers has been a central feature of its role in the cluster. Moreover, Dalum et al. (2002: 16) argue that the university's research orientation ("basic research with a sufficiently application-oriented touch") in close interaction with local industry constitutes a core asset of the region attracting the attention of major multinational companies. Also the NOVI science park can be considered as an indication of the successful integration between private and public organisations around wireless communication in North Jutland.

A similar story goes for functional foods in Scania yet on a much more moderate scale in terms of companies. Holmberg (2003) identifies three dedicated functional food firms that constitute the core of this embryonic cluster. In line with findings for the Swedish biotechnology-pharmaceutical sector in general (McKelvey et al. 2003) inter-firm knowledge linkages are weak even though the firms are co-located. Instead, the firms co-operate with firms and research organisations on the regional, national and international level. Notwithstanding this, the firms' location close to Lund University remains of fundamental importance through the presence of world-class research and education facilities in the field of functional foods. This has been further reinforced by the recent establishment of the cross-faculty research centre Functional Foods Science Centre. It can therefore be argued that Lund University in fact serves as the essential backbone for the commercial exploitation of functional foods in Scania as well as for the further development of a true functional foods cluster.

As table 2 indicates, the Horten case serves as an exception to the suggested proposition. Right from the beginning in the 1960s, the pioneering firms of the cluster had knowledge linkages which were mainly embedded in the national system of innovation. These firms were in fact spin-offs from important national knowledge organisations and were established based on product ideas that originated there. Also later on, the (radical) product development mainly drew on co-operation with technological R&D institutes and large public and private client in Norway, and in project often partly financed by the national research council (Isaksen 2003). Again, this should be contextualised through the Norwegian tradition for nation based R&D programs. In contrast, the regional knowledge infrastructure was of little value for the electronics cluster. For the technologically advanced system houses and OEM-suppliers this is nowadays still the case. According to Isaksen (2003) these companies have even grown out of the national innovation system that they rose from and are increasingly collaborating on an international level with firms and R&D institutes. What ties these firms then to Horten? This stickiness should be understood through the build up of unique competences among key personnel attached to the locality (Asheim and Isaksen 2002). Furthermore, the role of local subcontractors appears to be highly important. These have started their business since the beginning of the 1980s after the system firms closed down their in-house production facilities. While the knowledge-base of the system houses and OEM suppliers tends to be more inclined to an analytical knowledge base, innovation activities of these local subcontractors typically build on a synthetic knowledge base.

6: Conclusions

In this paper we made the argument that in a learning economy clusters and RIS need to be treated as two different yet strongly interrelated concepts. In short the distinction boils down to the notion that the cluster concept is substantially narrower than the RIS concept because of the strong sectorial connotation in clusters whereas a regional innovation system can transcend multiple sectors. Also from a policy perspective it is important to keep this distinction in mind due to the difference in sector specificity versus genericness. Furthermore we analysed the relationship between clusters and RIS from an industrial knowledge base perspective on the basis of a comparison of Nordic clusters. This indicated that clusters drawing on an analytical knowledge base tend to be more integrated in the regional innovation system than clusters drawing on a synthetic knowledge base where the two are more loosely connected (i.e. an auxiliary configuration). Also Cooke's (2003) findings on biotech clusters (which is a prime example of an analytical industry) as being intrinsically tied to regional knowledge 'fountainheads' corroborates this proposition. Notwithstanding this, the case of the electronic cluster in Horten showed weak linkages with the regional knowledge infrastructure. This needs to be understood against the background of Norway's traditionally national science and technology orientation.

However, as a result of empirical studies which have emphasised the significance of the regional level in economic development (in addition to - and sometimes over - the national level), a strong case has been made for an approach geared to region-specific innovation activities. The core of the argument is that close proximity between actors and organisations strongly facilitates the creation, acquisition, accumulation and utilisation of knowledge rooted in inter-firm networking, inter-personal relationships, local learning processes and 'sticky' knowledge grounded in social interaction (Asheim and Isaksen 2002).

In a globalising learning economy characterised by vertical disintegration and distributed knowledge bases, the important perspective ought to be the interdependences between regions and nations, where the deciding criteria must be the location of core activities (and not the whole value chain as such) and the relative importance of their connections to regional knowledge infrastructures. The argument that "production configurations are often dependent on structures and developments which are shaped and take place outside" of the actual regional territory (Bathelt 2003: 796) could as easily apply to most small and medium-sized countries as to regions, especially if being members of supra-national organisations such as the EU. Also from an institutional perspective it is essential to recognize the interlocked character of a region in a wider geographical context (Howells 1999). It acknowledges the importance of institutions negotiated and designed at the supra-regional level but at the same time it also allows for differentiation in terms of the impact of overarching institutions on the regional level as well as for differing degrees of regional institutional autonomy. More research on across geographical scales is needed to avoid the kind of spatial fetishism that deals with territorial innovation systems in a container-like way.

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