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Clusters in Time and Space: Understanding the Growth and Transformation of Life Science in Scania

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Keywords: life science, cluster, Scania.

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Abstract

This paper deals with the growth and development of the Scanian life science cluster by revisiting a previous empirical study in the light of new theoretical findings. It is argued that the transformation of the Scanian cluster must be evaluated with reference to the general development of the life science sector in Sweden as well as internationally. Therefore the position of Scania in different systems of regions must be taken into account. Patterns of functional interdependency within as well as between regions thus need to be explored on equal terms. This paper particularly highlights the importance of Stockholm/Uppsala for the growth and evolution of the Scanian cluster.

Keywords: Cluster, System, Regions, Life Science, Sweden

JEL classification: L65, O18, O33

Introduction

In 'the globalizing learning economy', the question of where and in what way competitiveness is created and sustained is as relevant as ever (Archibugi and Lundvall, 2002). Searching for answers to how regions could survive in a world of increasing global competition in many industries has prompted numerous scholars and policy makers to look for new alternatives to theories of regional growth. Even though scholars of economic geography and adjacent disciplines for a long time have discussed benefits and drawbacks of different types of geographical agglomerations of related activities, Michael Porter's (1990) influential book on industrial clusters opened up for a renewed interest for regionally indigenous transformation and growth. Indeed, the writings that followed the Porterian approach catalyzed an already growing interest in regional dimensions of economic growth among scholars as well as policy makers.

This paper deals with one of the most characteristic growth sectors of the new economy, life science, and the development of a life science cluster in Scania (southern Sweden). The purpose of the paper is to revisit a study made in 2002 (Nilsson et al, 2002) and, in light of recent developments in geographic theory and with new possibilities opened by new empirics, (a) deepen the historical description of the life science cluster in Scania, (b) map and analyze the territorial distrubtion of knowledge collaboration among the actors in the cluster, and (c) and discuss the role of Scania as a part of national and international systems of regions. The paper is outlined as follows. First, we give a brief introduction to the porterian cluster approach. This is followed by a presentation of previous research findings on clusters in Scania, as well as new data and an analysis of the Scanian life science cluster. The paper ends with a summary and conclusions which includes suggestions for further research.

Geography and the porterian cluster approach

To begin with, let us briefly turn towards the strategy- and micro-oriented cluster approach. In Michel Porter's (1990) influential book, *The Competitive Advantage of Nations*, four central parameters in defining the growth and competitiveness of a cluster are specified (the famous 'Diamond'): 'factor conditions', 'related and supporting industries', 'demand conditions', and 'firm strategy, structure and rivalry'. In addition to these, Porter discussed two exogenous dimensions which he labelled "government" and "chance". Although from the beginning intended as an instrument of analysis on a national level, the cluster approach has become one of the most influential expressions of the interest in the specificities of regions. The porterian cluster approach has thus been further elaborated and applied on a regional level (e.g. Malmberg, 2003). The 'standard' definition of regional clusters is "[…] 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." (Porter, 2000, p. 253). This definition has the merit of capturing two essential features of cluster theory: (1) the importance of agglomeration, and (2) the dual nature of cluster interaction in terms of both competition and cooperation. A concept central to agglomeration theory in general and the cluster perspective in particular is that of externalities and external economies (Marshall, 1920). While both externalities and external economies are external and unpriced effects that accrue to an actor, the two concepts are distinguished by the fact that while externality is a general concept, external economies is directly related to an increase in scale, i.e. increasing returns to scale. Thus, external economies of scale thereby provide groups of small firms with "a competitive alternative to the internal economies of scale of big companies" (Asheim, 2000, p. 415). The specific type of externalities and external economies that are of particular interest within cluster theory are those related to the spatial concentration of economic activity. These types of external effects are termed agglomeration externalities and agglomeration economies. For example, a skilled labour force could be built up collectively and regional investments could be shared among many (Malmberg and Maskell, 2002).

As part of this discussion on the different advantages of clusters and spatial agglomerations, cluster benefits with regard to innovative interaction and knowledge collaboration are stressed. This is indeed what could be expected from the great interest in innovations in later years, an interest primarily due to new prerequisites of competitiveness in the post-fordist production system. Even though the stressing of innovations as an endogenous factor in economic transformation and growth not is a new feature of economic theory (Schumpeter, 1951), innovation processes are today increasingly seen as interactive, iterative, and cumulative (Fagerberg et al, 2005). Within the realm of economic geography, the territorial dimensions of these processes are stressed. Everything else being equal, interaction is cheaper, faster and smoother the shorter the geographical distance between actors, as for example, within a regional cluster.

Thus, there are a number advantages with spatial agglomerations of related activities. But the regionalized version of the cluster approach has also been subject to extensive critique (Malmberg and Maskell, 2002; Martin and Sunley, 2003). A reading of these critical comments highlights at least four weaknesses: (1) conceptual confusion, (2) problems with defining the scale and scope, (3) disagreement on the theoretical implications of empirical results, and (4) disunity whether clusters can be deliberately ‘created’ or not (Nilsson et al, 2002). From a geographical perspective, it is especially important to problematize the role of spatial proximity to externalities and spill-over effects promoting innovation and growth. Though facilitative, pure geographical proximity is not sufficient for externalities to appear. Actors involved must also share some basic conventions, feel associated to, and trust each other. By being close in space, trust and understanding is gained and sustained, partly because reputation is often produced and reproduced in local communities. Yet, trust and understanding can not be based on reputation only, but relies on more generally accepted societal institutions guiding individual behaviour (Asheim and Gertler, 2005; Gertler, 2004; Saxenian, 1994). These institutions are often considered territorially bound and therefore used to support the argument of geographical proximity as precondition for externalities.

Also dealing with the role of spatial proximity, Bathelt et al (2004) have suggested a complementary 'local buzz, global pipeline' model capturing also extra-regional cluster linkages. The basic idea is that the localized learning processes (local buzz) that take place among actors embedded in a cluster just because they are located there are complemented by extra-cluster knowledge flows accessed by investments in channels of communication (pipelines). In the reminder of this paper, we will depart from these recent theoretical developments and discuss the growth and development of a life science cluster in Scania.

Clusters in Scania

Scania is the southernmost province of Sweden, and part of the Swedish-Danish cross-border Øresund region (see figure 1). Scania has approximatety 1,3 million inhabitants and is located 600 kilometres from the Swedish capital Stockholm. However, the Danish capital Copenhagen is merely 40 kilometres away from the largest city in Scania, Malmö, which also is the third largest city in Sweden.

< FIGURE 1 HERE >

In Scania, like in many regions in Sweden and all over the world, the cluster approach has received considerable attention from regional development agencies as a development tool in their efforts to promote economic development (Andersson et al, 2004). In the fall of 2001 the regional development authority in Scania (Region Skåne) decided to initiate a broad based analysis of the industry structure in the region. The study was conducted in cooperation with Lund University and the aim was to identify industrial clusters in the region (Nilsson et al, 2002). In the initial stages of enquiry, about 50 officials and business representatives with extensive knowledge of the Scanian economy were interviewed and asked to suggest potential regional clusters. The cluster definition used at this stage of enquiry was deliberately inclusive and as a result the suggested clusters ranged from global networks to local agglomerations of two or three firms. This is interesting, as the interviews displayed not only the conceptual problems with the cluster approach, but also the varying levels of acquaintance with agglomeration theories among regional development officials and business representatives.

Among the suggested clusters, several could be dismissed at an early stage. 16 were however selected and subject to further in-depth analysis with regard to four parameters: (1) scale, (2) actors and networks, (3) core competences, and (4) growth potential. These parameters were inspired by the nine dimensions characterizing clusters proposed by Michael Enright (2000). At this stage of the enquiry, additional interviews (about 150 additional personal and telephone interviews) were made through a 'snowball procedure', and cross-sectional data from Statistics Sweden as well as secondary written material was used for analysis of the sectors from the cluster perpective. The analysis followed the parameters above in an effort to make the accounts of the sectors comparable. *Scale* defined the size and relative regional agglomeration of the sector and the prevalence of a critical mass of firms. Under the heading *actors and networks,* key actors as well as the formal and informal interaction between actors within the sectors were discussed. *Core competence* aimed to capture the quality of education and research institutes, as well as their interaction with industry. *Growth potential* was related to the collective abilities and incentives of the sector to involve in radical change and upgrading of its competitiveness through for example the internalization of new technology and cooperation initiatives on a regional basis.

With regard to these four parameters, the analyzed ‘cluster candidates’ were positioned in a four-field taxonomy of (1) profile sectors, (2) sectors with no cluster tendencies, (3) sectors with some cluster tendencies, and (4) sectors with clear cluster tendencies. The profile sectors are sectors that create a value-added to regional firms. However, they are too heterogeneous to be labelled clusters. Sectors with no or some cluster tendencies lacked all or some characteristics of a cluster. Sectors with clear cluster tendencies fulfil the criteria of a cluster as defined in the study, meaning (1) that there is an agglomeration and a critical mass of economic activity, (2) that key actors and activities are located in the region and that there is a certain amount of interaction between these actors, (3) that there are high quality education and research, and (4) that there is a large potential for growth within the sector. The classification of the sectors analyzed is presented in table 1. As the table illustrates, the only sectors showing clear cluster tendencies were food and life science. They were characterised by a high degree of agglomeration, an internationally competitive knowledge infrastructure, and high degree of interaction between academia and business.

< TABLE 1 HERE >

The growth of the Scanian Life Science Cluster

The Scanian life science cluster comprises firms and organizations in three main fields: pharmaceuticals, medical-technical equipment, and biotechnology. An understanding of the growth of the cluster must be related to larger patterns of renewal and transformation in the Swedish economy. Such processes of economic transformation can be observed on a variety of scales, from product level and new and changed production functions to the overall composition of the aggregated economy. Schön (2000, 2005) provides solid evidence of a period of dramatic renewal in the Swedish economy after the downswing and structural crisis in the 1970s, the renewal being primarily associated with the implementation of ICT, institutional and political reforms, and the transformation towards a service economy. This view of the historical development of the Swedish industry is very close to the arguments of proponents of Schumpeterian economics and economic history, who stress long-wave tendencies of economic development. In the strongest versions of these theories, technological, managerial and institutional complementarities form a structure which defines the wider frameworks of economic growth (Freeman and Perez, 1988; Perez, 1983). These theoretical accounts emphasize the importance of path-breaking innovations and their diffusion to industrial transformation and aggregated economic development. Thereby they stress the constant transformation processes taking place in the economy. We will now discover that the growth of the life science sector is an important part of the contemporary transformation of the Swedish manufacturing industry.

Though the 1970s crisis was a serious blow to several traditional industries, it opened up for growth complementarities released by the introduction of new technologies. This goes well together with the new structural dynamics of a proposed international fifth Kondratieff wave (Freeman and Lourça, 2001), where computer industry, telecom, and biotechnology are seen as the carriers of the growth opportunities created by new technologies. With this theoretical background, and creating a taxonomy of Swedish industrial growth in four-year periods 1978-1998, Lundquist et al (2005) identify the pharmaceutical industry as being one of the leading transformation industries in the new phase of economic development.

Obtaining comparable descriptive time series on regional and aggregated national level for detailed industry classification for the period from the mid 1970s until today has proven to be a painstaking endeavour. With the compilation of the unique datasets in the DEVIL databases (Databases of Evolutionary Geography in Lund, containing own calculations from Statistics Sweden data), fragments of such series could be extracted with regard to the Scanian life science clusters. Work is under progress to compile comparable regional time series suitable for statistical analysis. From figure 2, it is evident that value added in the pharma industry has increased dramatically, especially since the Swedish crises 1990. Viewed from this perspective, the crisis in the early 1990s was the starting point of en extensive renewal of the Swedish economy, both in terms of economic policy and institutional reforms (Eklund, 2005) and in the manufacturing sector (Lundquist et al, 2005). The growth of the sector “manufacture of pharmaceuticals, medicinal chemicals and botanical products”, in the following referred to as the pharma industry (which is an important part of the life science sector), is significant both in current and fixed prices. Indeed, the increase in volume produced (value added) was over 2000 percent in nominal prices and well over 600 percent in fixed prices during 1978 to 2001. The same picture goes for the increase in number of employees, as shown in figure 3. In the period 1978 to 2001, number of employees in the pharma industry increased with over 100 percent. This aggregated national growth trajectory of pharmaceutical industry in Sweden is however, as we shall see, subject to extensive regional variations.

<FIGURE 2 HERE>

<FIGURE 3 HERE>

This aggregate description of the growth of the pharma industry naturally conceals many interesting geographical dimensions, but it is indeed an interesting background to a description of the growth of the Scanian cluster. Even if the interest concerning the sector intuitively seems to have grown in the later years in Scania, manufacturing and research in life science has a long tradition in the region. A fragment of historical evidence of the interest in life science activities is given in a volume from the 1950s about Malmö, the largest city in the region: “The pharmaceutical industry in Malmö has acquired solid international reputation through Ferrosan, where PAS – the world’s first tuberculosis medicine – as well as the anti-thrombous medicine AP are manufactured in large scale. Here, it is as much a question of a scientific institute of research as of manufacturing.” (Malmö i bilder, 1954, own translation from Swedish). The text is accompanied by a picture of men in white coats and ties in a laboratory mixing solutions for the future benefit of humankind. So, as early as in the 1950s, life science in Scania was noted for its prominent position in research and manufacturing of pharmaceuticals.

This growth of life science in Scania seem to be coordinated in time with a general, world wide, expansion during the last two decades, connected to the introduction of new technologies. Particularly in pharmaceuticals this is the case. As regards scientific profile, the pharmaceutical industry has gone from being almost totally based on chemistry to the introduction of biology based technologies, starting with a couple of breakthrough inventions in the early 1970s. Even though biotechnology has a much longer history than this (fermentation processes has been used frequently in food an (chemistry based) pharmaceuticals since the early 1990s), the 'new biotechnology' applications (which is what is referred to as biotechnology in this paper) took off in a dramatic way during the 1990s. Particularly recombinant DNA (rDNA) based on findings by Stanley Cohen and Herbert Boyer in 1973 and monoclonal anotibodies (MAbs) developed by Georges Kohler and César Milstein in 1975 are key applications. In the second half of the 1990s the number of potential 'new biotechnology' applications in life science has exploded, which not only can be seen in growth of total activity, but also in number of actors. The increase in potential applications has led to increased complexity which has made it impossible for large pharmaceutical companies to host all necessary competences in-house, and hence paved the way for small specialised research oriented biotechnology firms (DBFs), today often seen as 'the core' of life science clusters (Carlsson, 2002). Only in Scania, the number of DBFs has multiplied since the mid 1990s, peaking in 2000, now comprising more than 30 relatively successful DBFs. Several of these are specialised in MAbs. Similar trends can be seen in many other regions.

The growth of the Scanian life science sector has varied over time. A longitudinal account of the evolution of the Scanian life science sector is presented in table 2. Numbers of employees are chosen as indicative variable[1]. We use the pharmaceutical industry as proxy of cluster growth in the early periods, while the later periods includes more precise data of the three fields of life science. Even though we have made extensive efforts to ensure the quality of the data, it should be acknowledged that the interpretation must be made with care as we deal with historical data on a regional level.

[1] In this context, the alternative to obtaining comparable time series for the whole period in the old SNI69 nomenclature is not taken advantage of, as we wanted to allow maximum flexibility with regard to nomenclature improvements during the period. This is the reason why four separate periods of growth are used (more exhaustive description of the data could be found in Lundquist et al, 2005).

< TABLE 2 HERE >

In comparison with the national figures during the period 1974-1977, the growth of the pharmaceutical industry in Scania was slightly lower. It is though interesting that the pharma industry displayed growth at all, as the first period 1974-1977 coincided with the major industrial crisis in Sweden during the mid 1970s. However, even if displaying growth, Scania was not the national growth engine of the sector during this period. This goes also for the first years of structural renewal of the Swedish economy between the years 1978 and 1982, when the growth of the Scanian pharmaceutical sector was negative with regard to number of employees. The relative growth during the period 1983-1993, was in parity with the national figures. During the end of this period a major economic downswing affected the Swedish economy. The fact that the growth tendencies of the life science sector with only minor fluctuations persist during the crisis, demonstrates the growth power of life science in this period of structural change. After the crisis, the Scanian cluster has grown substantially, showing an increase in number of employees of 86 percent. Even if the changing population definitions over time makes it somewhat hard to draw conclusions regarding the longitudinal growth of the Scanian life science cluster as a whole, some features stand out: the low growth (indeed, decline) of the pharmaceutical industry in the late 1970s and early 1980s, the growth in parity with the national numbers during the middle and end of the 1980s and early 1990s and the rather sensational growth during the rest of the 1990's and the first years of the new millennium. Even if the descriptive statistics on the cluster development becomes more reliable over time and the service sector is not included in the earlier periods, we can conclude that there seem to be some correspondence between national and Scanian growth figures over the periods defined. Yet, further research has to reveal the reasons for the asymmetric growth shown among Swedish regions and how the national growth figures are distributed among Swedish regions over time. We will address these questions below.

If we have a look at the most recent figures, the Scanian life science cluster, (including biotechnology, the pharmaceutical and medical-technical industries, whole sales with medical products, and medical research outside university) employed roughly 8 000 people in 2002 (which corresponds to 1/3 of the number employed in the same sector in Stockholm/Uppsala). If university research and public healthcare is included (which according to our definition would be an overstimation of the size of the cluster), this number would rise to about 50 000. Today, several well-known firms are located with production and/or research in Scania. These firms include Pfizer and AstraZeneca (pharmaceuticals), Gambro (medical-technical equipment), and Active Biotech (biotechnology). In addition to these large corporations, a number of small and medium-sized firms are located in the region. Some examples are Bioglan and Qpharma in pharmaceuticals, Arjo Hospital Equipment in medical-technical products, and BioInvent and Camurus in Biotechnology. Looking specifically at biotechnology, often defined as the ‘core’ of life science (Carlsson, 2002), there are about 30 dedicated biotechnology firms (DBFs) located in the region. This agglomeration does not reach the scale of the globally leading biotech megacentres such as Boston and San Diego (Cooke, 2004), but in a Scandinavian perspective only Stockholm and Copenhagen host more biotech firms. Major strengths in Scania are the research fields of diabetes, inflammation, neuroscience and cancer (Boston Consulting Group, 2002).

In science-based activities such as life science and especially biotech, boundaries between research and business are not easily drawn. This goes also for the Scanian life science cluster. The universities and university hospitals in Malmö and Lund are essential parts of the Scanian life science cluster and often seen as its engine, as they drive the progress of research and innovation at the same time as they (i.e. the hospitals) represent the demand side of the cluster. The Faculty of Medicine at Lund University employs 140 professors and 500 other researchers, in addition to 900 postgraduate students with 100 dissertations presented annually. In year 2000 Malmö University Hospital occupied 250 researchers in biomedicine (MAS, 2000), and a clinical research centre will be opened in 2006 occupying approximately 420 employees in experimental clinical research (CRC homepage). In addition to this, a biomedical centre in Lund opened in 2001, occupying 700 scientists including 50 affiliated professors (BMC homepage).

The majority of firms in the Scanian cluster are located on the west coast, close to Denmark and the Greater Copenhagen region. Some years ago, a bridge was opened over the sound, and with this came increasing expectations of an integrated Øresund region with beneficial effects for economic activity. An example of the cross-border initiatives taken with varying success in later years is the Øresund Science Region, which has the official aim "to stimulate the process towards developing a knowledge-based economic growth spiral in the region, because we will see over the next decade or two that the build-up, transfer and commercialisation of knowledge will become one of the most important economic growth factors in an ever more competitive world." (ØSR homepage). In 1997, the network organization Medicon Valley Academy (MVA), a part of the Øresund Science Region umbrella, was formed. Today, it comprises of about 250 members. As a member financed network organization MVA works to promote interaction and knowledge transfer between academia, public health and the life science industry (MVA homepage). However, the establishment of a cross-border life science cluster is still in its infancy (Nilsson et al, 2002). Several studies indicate that even though strong life science clusters exist on both sides of Øresund, the cross-border linkages are weak (MVA, 1999; Coenen et al., 2004; Lundquist and Winther, 2003).

As we have previously mentioned, recent theoretical developments in geography in different ways stress the complementary features of intra- and extra-cluster interaction when it comes to innovation and knowledge exchange. In the context of a Scanian life science cluster, it is therefore relevant to take a closer look than previously made on knowledge collaboration in the cluster. To do this, we have chosen to make an analysis directed especially on DBFs.

Knowledge collaboration in the Scanian life science cluster

Several studies of knowledge interaction in biotech clusters indicate a dual configuration of local and extra-local networks (Cooke, 2004). The Scanian case is no exception. The intra-regional linkages are however not evenly distributed and the extra-regional ones are not randomly spread. Rather the collaboration seem to follow a well defined pattern with the 'megacentres' globally interconnected (Cooke, 2005). In the following we present an overview of the knowledge collaboration among DBFs in Scania. As indicators of knowledge interaction we use co-publications and co-inventions, complemented by in-dept interviews also covering knowledge interaction not yet manifested in scientific publications or patents.

Based on our interviews we find that, even though both local and global collaboration appears, the 'local buzz-global pipelines' argument provided by Bathelt et al (2004) is somewhat problematic when applied to life science clusters. The reason for this is that it accents the complementary role of local and global linkages by ascribing them distinct characteristics. Spontaneous local learning in communities (buzz) versus structured channels with the outer world (pipelines) may be valid for some industries, but as a general statement it is somewhat dubitable. In biotechnology and other life sciences, universities and public research organizations are key players in the innovation process.

Since public research is inherently open, knowledge spill-overs (buzz) are at least in theory omnipresent. At the same time, in practice, informal collaboration (buzz) hardly exists anywhere. As soon as contact is established, contracts are signed. Therefore local and global knowledge exchange must be studied on equal terms (i.e. as pipelines), and not as distinct phenomena (Owen-Smith and Powell, 2004).

In our bibliometric findings, the local-extra-local configuration of collaborative relations is clearly visible. About 50 percent of all knowledge collaboration is intra-regional, while the remaining 50 percent is distributed all over the world. Table 3 illustrates the distribution of extra-regional collaborators of Scanian DBFs as reflected in patents and scientific publications.

< TABLE 3 HERE >

Among the nodes outside Sweden, particularly the Oxford/Cambridge/London region seems to be important, however still hosting less than 10 percent of all extra-regional collaboration partners. More strikingly though is the fact that the Scanian biotech firms collaborate more with actors in Stockholm than in close-by Copenhagen or any other global megacentre. Also compared to the third bioregion in Sweden, Göteborg (250 kilometres north of Scania), Stockholm is far more represented. Four percent of all extra-regional co-authors and five percent of all extra-regional co-inventors are located in Göteborg, which makes this node somewhat more important than Copenhagen but less important than Stockholm. In interviews with managerial research staff in nine Scanian DBFs, this was problematized. Two explanations to Stockholm’s strong role in the Scanian DBFs’ networks can be highlighted. Firstly, Stockholm is the home of the Karolinska Institute, one of the world’s leading research entities in the field of biotechnology. New research findings from

Karolinska Institute are often adopted and further explored by firms in Scania. Secondly, Stockholm is the capital of Sweden, hosting a large and diversified regional economy with many actors in different segments of the biotechnology knowledge field. This makes the number of potential partners larger in Stockholm than in any other part of Sweden. However, despite this intra-national preference, the impact of nationally governed institutions as potential explanation was downplayed by the research managers. Instead they referred to the fact that the research community they are involved in is centred in Stockholm and that they therefore tend to engage in collaboration with partners in Stockholm more often than in Copenhagen even though Copenhagen could provide an equivalent pool of competence as Stockholm. Hence there is, as highlighted by scholars such as Lundvall (1992), Whitley (1999), Gertler (2004) and others, something in the national configuration that makes intra-national knowledge collaboration more frequent than international. It is though not only a matter of nationally governed institutions and it seems that pure geographical proximity is of minor importance here. Otherwise Göteborg would have been more represented in collaboration since it is located less than half the distance from Scania compared to Stockholm and it has about the same biotech profile as the other two Swedish nodes (Vinnova, 2005).

All DBFs analyzed also have strong linkages to Lund University. However, these linkages are not primarily supported by spatial proximity but by common history and scientific similarities (Moodysson and Jonsson, 2007). The firms do not collaborate with actors at Lund University because the exchange of knowledge as such require spatial proximity, and neither because they have strong interpersonal ties there. Rather they feel confident collaborating with these partners because they know their specific competence, since they come from the same educational environment or because the firm was founded as a spin-off from that particular department. However, important to note, this local collaboration is as formalized as the global. The firms do not experience any ‘local buzz’, informal collaboration, or unintended and unregulated knowledge spill-over. Personal friendship can not substitute written agreements and reputation may help when potential partners are identified but not when interaction is initiated. Furthermore, the DBFs are, according to the research managers interviewed, far too specialized to benefit from such informal discussions with their neighbours anyway.

Also when further analyzing a selection of extra-regional collaborations by decomposing and recomposing the project constellations it became evident that history could explain at least as much, if not more, than geography. The importance of Stockholm as collaboration node is, as discussed above, to a large part explained by Stockholm’s size, but also by historical factors connected to particular individuals. Through previous collaboration, either within the DBF or in other contexts, the research managers have established contact with other research entities such as e.g. Karolinska Institute. This does not necessarily mean that they have personal relations to these entities anymore but, similar to the situation with Lund University, that they know where to find the competence they need in this new situation. Similar stories can be told about several collaborations with actors in international centres of excellence or megacentres. Part of the explanation is found in the fact that these centres provide a large pool of potential partners, but another important explanatory factor is the research managers’ personal history. One of the DBFs analyzed had a large number of collaboration linkages to a region in Poland. When analyzing this by sketching the biography of these projects it was evidenced that the researcher managing these projects had historical connections to a university in that region and therefore felt confident in collaborating there even though his own personal network did not remain there anymore. Another DBF had a large number of collaborations with actors in Oslo (Norway) which was explained by the fact that one research manager had been a professor at the University of Oslo earlier in his career.

The Scanian Cluster in a Swedish Context

The results of our analysis of knowledge collaboration above indicate that when it comes to innovative activities within biotechnology and possibly within life scince in general, the benefits of immediate spatial proximity to collaboration partners is not obvious or could at least not be taken for granted. But what does this tell us about the development of such sectors, within a nation, in this case Sweden? Well, even if the research on the particular regions of course has provided us with valuable insights on regional contingent conditions of growth, we do agree with Martin and Sunley's statement that: "[…] the emphasis remains firmly in the contingent condition or growth in *particular* regions, rather than on the long-term evolution of the *entire* regional economic system." (Martin and Sunley, 1998, p 202). This focus might to some extent have hampered our understanding of the growth and transformation in individual regions. Transformation patterns in individual regions are strongly dependent on development trajectories of other parts of the regional system, and cannot be understood without taking the development of the regional system as a whole into account. Our empirical data support this conceptual point. However, the problem is still how to incorporate this view within an applied theoretical framework. One way to do this is by adopting the idea of systems of regions. The perspective is based on a general assumption about regional division of labour, and emphasizes that cluster growth and other benefits accruing from regional externalities must be seen in a perspective of regional complementarity and competition. Such a perspective was more common in Swedish geographical studies in the 1960s and 1970s (Pred, 1973; SOU 1979:70), but seems to have given way to the micro-oriented approaches providing us with in-depth understanding of the internal dynamics of clusters and regional innovation systems, and it might be the case that the the formalized theory-building approaches of economics instead have taken over the development of the system models (Duranton and Puga, 1999).

The implications of these arguments in the context of the life science cluster in Scania is rather straight forward. If we want to explain why and how the cluster has grown and why innovations are created here, we can search for explanations in the cluster theory, but it is not obvious that the knowledge dynamics of the cluster, and thus innovation creation, is only understood though the gaze of the cluster theory. To illustrate this point, let us have a look on the Swedish system of regions. In the case of Sweden, Stockholm has by far the most diversified economy and the largest regional market. This is emphasized in several empirical studies. Moreover, Stockholm serves as an import node for information and technological impulses to the national system through for example import firms (RTK, 1998). Lundquist and Olander (2001) argue for a theoretical position where new innovations of different kinds often spread from Stockholm. The spreading of new technologies and trends are initiated from there because of the diversified economy, a large regional market and availability of advanced factors of production. This does of course not mean that all innovations are created in Stockholm, but rather that the results of new development blocks (Dahmén, 1988) often are brought to commercial application in Stockholm first.

More empirical investigations are nedded on this issue, but we could, with support from our emirical findings, hypothesize that the growth of the life science cluster in Scania has taken place as a process integrated in the evolution of the life science sector in the Swedish national system. It could therefore be interesting to compare the growth of the Scanian life science cluster with the growth of the sector in the Stockholm/Uppsala region.

< TABLE 4 HERE >

The strong growth of the Scanian life science cluster during the late 1990s and early 2000s was preceded by early tendencies of growth in the Stockholm/Uppsala region during the period 1978-1982. Our findings suggest that Stockholm/Uppsala was the engine of the national life science growth in the early phases of structural renewal in the Swedish economy after the 1970s crisis. In the period 1983-1993, the growth in the life science sectors in Scania and Stockholm/Uppsala was almost equal, but it is interesting to note the relatively strong growth also during this period ending with the crisis of the early 1990s. Thus, Scania seem to have taken over Stockholm/Uppsala's leading role as growth engine during the period 1994-2002 even if the growth occurred from quite low numbers.

To explore the reasons for the regionally desynchronised growth in the life science sector in Sweden, we need further explorative research. In fact, our understanding of the national processes of transformation and growth in Sweden during the post-war period is quite well-developed (Schön, 1995, 2000, 2005; Eklund, 2005; Jörberg, 1991). So far, however, regional implications of the transformation processes have been less explored. Our lack of detailed systematic understanding of the geographies of long-term transformation and growth, on the theoretical as well as on the empirical level, is therefore extensive, at least in the case of Sweden. This makes comparisons between the long-term development of clusters and the importance of cluster effects hard to assess. Some important studies have however contributed to an increased understanding of the dynamics of regional transformation in Sweden, foremost from the formal modelling perspective of regional economics (Karlsson and Nilsson, 2002; Forslund, 1997). Recently, economic geographers have begun to show interest in specifying the detailed regional dimensions of transformation and growth during the period after the oil crisis in a context of non-formal approach inspired by the theories of the Swedish economist Erik Dahmén (Lundquist et al, 2005). The understanding of clusters and the future prospects for cluster growth would benefit from a long-term view on regional industrial development. Previous studies indicate that Stockholm plays a unique role as a leader in the Swedish system (Lundquist and Olander, 2001; RTK, 1998; Karlsson and Nilsson, 2002), but the relationship between Stockholm and the rest of the regions in the system, and their respective roles in transformation processes, is still unclear. However, so far we can only conclude that prevalence of strong regional clusters must be seen in the context of the national system, and indeed not as isolated phenomena.

Summary and conclusions

In this paper we have tried to give an account of the growth and transformation of the Scanian life science industry. When studying the Scanian cluster it becomes evident that the cluster theory is a useful tool in identifying regional industrial strengths. We have though argued that the regionalized cluster theory as developed from Porterian writings in certain situations misses some crucial points when it comes to applied explanations of long-term regional economic growth and transformation.

According to our enquiries, when it comes to innovative collaboration and knowledge exchange which is pivotal for competitiveness in a learning economy, Scanian actors frequently collaborate with actors outside the region, also in rather advanced transactions. This may or may not come as a surprise, but it has implications when it comes to the ability of a regionalized cluster approach to explain the growth and transformation of the Scanian biotech cluster. Indeed, there seems to be a very limited degree of 'local buzz' in the Scanian biotech sector. Naturally, there are informal gatherings and the like for biotech actors and many actors have personal bonds to each other due to for example a common background in education and research. However, as collaboration and knowledge exchange in biotechnology often are highly formalized, the value of this regional concentration of actors seems limited when it comes to knowledge interaction and innovativity. This indicates that in order to understand the long-term growth and transformation of an agglomeration, a purely regional gaze is not enough. Nor is it enough to assume that the sort of interaction taking place within the cluster is of a different kind to the one taking place on longer geographical distances.

Our results instead indicate that long-distance interaction and diffusion of knowledge is important to the development of a cluster. Furthermore, it appears that some specific regions are particularly important as collaboration venues for the Scanian biotech actors. For example, Scanian biotech actors frequently collaborate with actors in the Stockholm/Uppsala region. We have described that the Stockholm/Uppsala region houses important research facilities and firms. The economic geographies of the biotech sector is therefore an archipelagic one, where the ‘own’ island could be, but not necessarily is, the most important for all actors when it comes to knowledge innovation. One explanation for these uneven geographies of biotech collaboration could be that some regions serve as leaders when it comes to the advent of new development blocks. For example, previous research has shown that Stockholm is an important leader in implementing new technologies and formation of new development blocks. Therefore, in order to understand the growth and transformation of the Scanian biotech cluster, it is necessary to understand its functional relation to technology leaders and the development of those leaders, be it Stockholm/Uppsala in a national perspective or Oxford/Cambridge/London in a European perspective.

The biotech sector is, in its current shape, a relatively new industry and Scania has historically been more well-known for its heavy machinery industry and agriculture, even if the medical/biotech sector broadly defined has a long tradition in the region. Of course, we cannot argue that the regional environment is unimportant to the success of biotech firms in Scania. But our indications are that the most important localized advantage is a specialized labour market, and not necessarily exchange of knowledge within the cluster that is different from the exchange that Scanian actors have with actors in for example Stockholm. This also implies that the growth and transformation of a cluster are governed in reciprocal processes taking place inside and outside the region. Regional development and transformation has to be understood in a system perspective, where some regions are indeed early adopters quickly implementing new technology, and other take on the role of followers. In the biotech example, we clearly see that the Scanian life science sector and the Stockholm/Uppsala cluster grow in a desynchronized fashion. Clearly, in such a small country, regions must be dependent on each other in the creation of innovation, growth and welfare. Yet, in the Swedish case, the longitudinal growth of regions and how they relate to each other in different phases of economic growth is poorly understood. This is why further investigations of the long-term dynamics of regional transformation and growth must be one of the central points of geographic research in the years to come as we search for complementary explanations to regional growth than the one delivered by cluster theory. This is a theoretical challenge, but also an extensive empirical one.

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Figures and tables

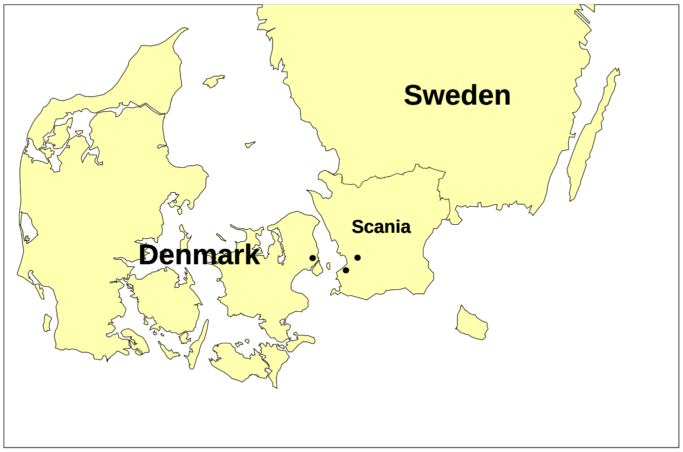

Figure 1: Map of Scania (southern Sweden) and Denmark.

Type	**Sector**
Profile sectors	Design, environmental technology.
No cluster tendencies	Logistics, music, metal manufacturing, computer games, film, shipbuilding, graphics, plastic industry.
Some cluster tendencies	Wood-related products, tourism, ICT-sector, packaging.
Clear cluster tendencies	Food, life science.

Table 1: Cluster taxonomy of the Scanian economy (Nilsson et al. 2002, p. 217).

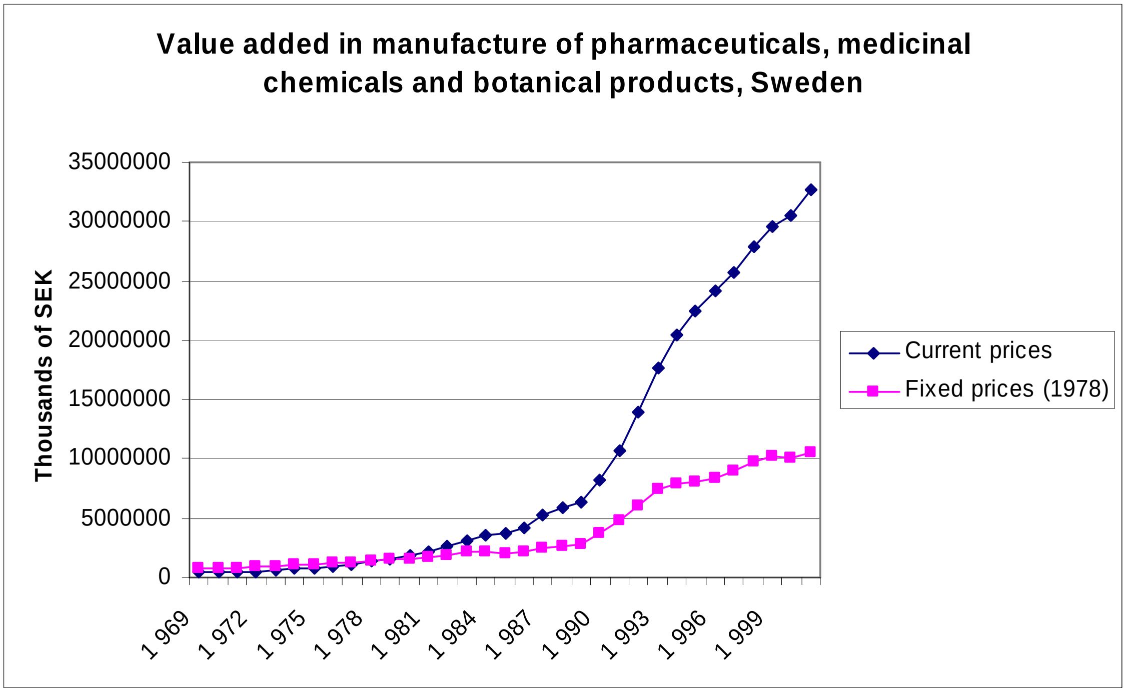

Figure 2: value added in the sector "Manufacture of pharmaceuticals, medicinal chemicals and botanical products" in Sweden during the period 1968-2001 (source: DEVIL databases). 3-years weighted arithmetic means (yearly weight for contribution to mean 0.25;0.50;0.25). Fixed prices are deflated from output series.

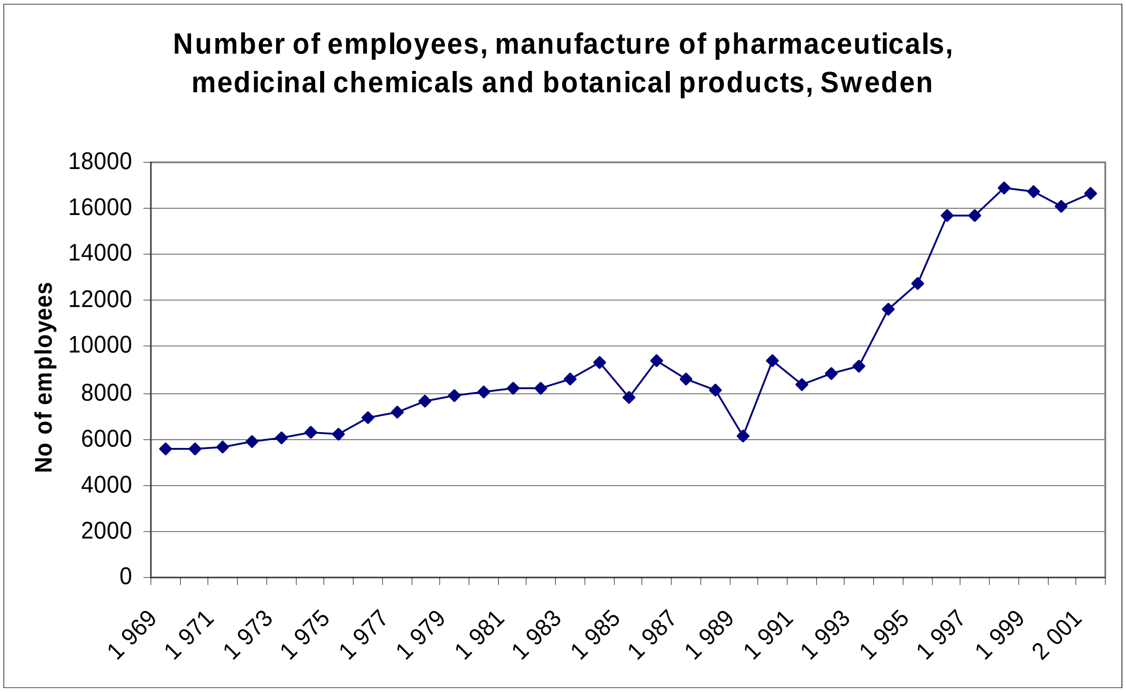

Figure 3: number of employees in the sector "Manufacture of pharmaceuticals, medicinal chemicals and botanical products" in Sweden during the period 1969-2001 (source: DEVIL databases). Absolute numbers per year.

	1974-1977[2]	1978 – 1982[3]	1983 – 1993[4]	1994 – 2002[5]
Growth in % in no of employees, Scania, whole period (national figures in brackets)	11.6 (15)	-7.9 (6.6)	36.8 (36.7)	86.4 (58.1)

Table 2: Indicators of the growth of the Scanian life science cluster. Source: DEVIL databases, own calculations from data supplied by Statistics Sweden. More detailed evidence cannot be presented due to confidentiality reasons.

[2] Includes data on pharmaceutical industry (SNI69 352200).
[3] Includes data on pharmaceutical industry (SNI69 352200).
[4] Includes data on pharmaceutical industry, medical R&D outside University (SNI69 352200 and 93203).

	Stockholm	Copenhagen	Oxford/ Cambridge/ London	Munich
Co-authors*	13	4	5	3
Co-inventors**	30	2	10	2

Table 3: Relative distribution (%) of extra-regional collaborators of Scanian DBFs among the most frequently represented regions 1990-2003. Sources: Science Citation Index and United States Patent and Trademark Office.
** N=216*
*** N=80*

[5] Includes data on pharmaceuticals, medical equipment, medical R&D outside University and wholesale trade with medical products

	1974-1977[6]	1978 – 1982[7]	1983 – 1993[8]	1994 - 2002[9]
Growth in % in no of employees, whole Stockholm/Uppsala, whole period (Scanian figures in brackets)	15.2 (11.6)	10.3 (-7.9)	34.6 (36.8)	33.3 (86.4)

Table 4: Indicators of the growth of the Stockholm/Uppsala life science sector. Source: own calculations from data supplied by Statistics Sweden. More detailed evidence cannot be presented due to confidentiality reasons.

(SNI92 24410, 24420, 33101, 73103, 51460).

[6] Includes data on pharmaceutical industry (SNI69 352200).

[7] Includes data on pharmaceutical industry (SNI69 352200).

[8] Includes data on pharmaceutical industry and medical R&D outside University (SNI69 352200 and 93203).

[9] Includes data on pharmaceutical industry, medical equipment, medical R&D outside University and wholesale trade with medical products (SNI92 24410, 24420, 33101, 73103, 51460).

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