

## Clusters and knowledge

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**Clusters and Knowledge:  
Local Buzz, Global Pipelines and  
The Process of Knowledge Creation**

by

Harald Bathelt, Anders Malmberg and Peter Maskell

# Cluster and Knowledge: Local Buzz, Global Pipelines and the Process of Knowledge Creation

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## **Abstract**

The paper is concerned with spatial clustering of economic activity and its relation to the spatiality of knowledge creation in various sorts of interactive learning processes. It questions the merit of the prevailing explanatory model where the realm of tacit knowledge transfer is confined to local milieus whereas codified knowledge may roam the globe almost frictionless. When doing so the paper highlights the conditions under which both tacit and codified knowledge can be exchanged locally and globally. A distinction is made between, on the one hand, the learning processes taking place among actors embedded in a community by just being there - dubbed buzz - and, on the other, the knowledge attained by investing in building channels of communication - called pipelines - to selected providers located outside the local milieu. It is argued, that the co-existence of high levels of buzz and many pipelines may provide firms located in outward looking and lively clusters with a string of particular advantages not available to outsiders. Finally, some prescriptive elements, stemming from the argument, are identified.

**Key words:** knowledge creation, clusters, buzz, pipelines, absorptive capacity

**JEL Codes:** D83, L22, R10

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## **1. Introduction**

The riddle we are dealing with in this paper is concerned with spatial clustering of economic activity and its relation to the spatiality of knowledge creation in various sorts of interactive learning processes. A condensed version of a knowledge-based theory of spatial clustering, to which the present authors have contributed in various papers in recent years,<sup>1</sup> goes as follows. Innovation, knowledge creation and learning are all best understood if seen as the result of interactive processes where actors possessing different types of knowledge and competencies come together and exchange information with the aim to solve some – technical, organisational, commercial or intellectual – problems. Such exchange and interaction can be organised in different ways. The main argument regarding the spatial aspects of this has been that – on the one hand – the more codified the knowledge involved, the less space-sensitive should these processes tend to be. If – on the other hand – the knowledge involved is diffuse and tacit, the argument is that such interaction and exchange is dependent on spatial proximity between the actors involved. Only by being in the same local environment, and by meeting repeatedly in person, can and will such more subtle forms of information be exchanged. This has been proposed as the main mechanism that makes it beneficial for a firm to be located in a spatial cluster, surrounded by other similar and related firms with which it can interact.

This paper grows out of a certain dissatisfaction with the above line of reasoning (see, also, Gertler 2001), as it does not explain why interactions and transactions between firms within a cluster are often fairly limited. The aim of the following, therefore, is to develop a crude but still somewhat more sophisticated line of argument that breaks out of the simple “tacit = local”-vs.-“codified = global” model, by highlighting the conditions under which both tacit and codified knowledge can be exchanged locally and globally.

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<sup>1</sup> Cf. Malmberg and Maskell (1997, 2002), Maskell *et al.* (1998), Maskell and Malmberg (1999a, 1999b), Maskell (2001), Bathelt (2001, 2002), Bathelt and Glückler (2002), Bathelt and Taylor (2002).

*Codified and tacit knowledge, local and global*

Codified knowledge may travel the world with gradually less friction thanks to relaxed trade regimes, emerging markets for intellectual property rights and improvements in information and communication technologies. Such reductions in the friction of space have sometimes led to the assumption that knowledge, once codified, is almost instantly available to all firms at zero costs regardless of their location.<sup>2</sup> However, in reality there are usually substantial, sometimes even prohibitive, costs associated with identifying, assessing, assimilating and applying codified knowledge already in existence and use. Attaining knowledge existing elsewhere requires decisions and investments and both contribute in making the possession valuable.<sup>3</sup> Even in cases where codified knowledge is actually almost omnipresent it may become valuable if (and only if) fused with less transitory knowledge whether proprietary or embedded in a local environment in tacit forms (Asheim 1999).

One of the main distinguishing features of geographical agglomerations or spatial clusters of similar and related economic activity is that they provide opportunities for the transmission of sticky, non-articulated, tacit forms of knowledge between firms located there.<sup>4</sup> However, when this locally embedded knowledge is combined in novel ways with codified and accessible *external* knowledge new value can be created. It is the quest for superior rents that compel firms in clusters not to rely on internal or local assets only, but to pursue systematically and sometimes vigorously potentially useful knowledge pools residing elsewhere (Scott 1998, Maillat 1998).

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<sup>2</sup> This is, for instance, the case in recent theories of increasing returns and endogenous growth and is spilling over into the models developed within the branch of economics which is sometimes referred to as 'new economic geography' or geographical economics (Fujita, Krugman and Venables 1999).

<sup>3</sup> If neither decisions nor investments were needed codified knowledge would indeed become a ubiquity and, as realized since Weber (1909) published his seminal work, would be without much value as no superior rents can be earned on ubiquities.

<sup>4</sup> There may be several, mutually reinforcing, reasons for the ease with which knowledge is communicated at the local level. Lawson and Lorenz (1999) emphasise, for instance, how actors in a cluster develop a common language, joint interpretative contexts and a shared knowledge basis. Grabher (2002b) has demonstrated how co-location facilitates the establishment of common interpretative schemes, especially through 'hanging out' in local 'communities of practice' (Wenger 1998). Such features have, furthermore, been proposed as a general explanation for the existence of clusters as well as for their sustained economic success (Malmberg and Maskell 1997).

This line of reasoning makes us suspect that the particularly successful clusters are the ones that are able to build and maintain a variety of channels for low-cost exchange of knowledge with relevant hot-spots around the globe (Bathelt 2001).<sup>5</sup> Though it is generally acknowledged that external sources of knowledge are often important triggers to stimulate growth within a cluster there is hardly any systematic analysis in the whole canon of economic geography that deals with the question of how the structure of interactive and knowledge-enhancing relations between firms differ within and across clusters.

#### *Aim and structure of the paper*

For reasons spelled out in this paper we maintain that the skills and efforts required when attending to the local environment are rather different from the ones necessary to maximise the inflow and utilisation of codified knowledge produced elsewhere, and that these differences must be managed. In this paper, our aim is thus to present an admittedly crude model that takes into account the global connections of firms in clusters while retaining the notion that in some crucial sense knowledge is created, stored and utilised locally in a decisive manner.

Our argument proceeds in the following way. In the next section we identify some important properties of knowledge creation within firms while emphasising reasons why many firms need access to knowledge produced elsewhere. In section three we take a closer look at inter-firm knowledge-creation at the local level, within the framework of geographical agglomerations or spatial clusters of similar and related economic activities. In section four we move on to what is the pivotal argument of this paper: the need to go beyond the borders of the cluster and build pipelines to bodies of knowledge residing elsewhere – sometimes very far away. The section discusses how this may be done and the balance that firms need to negotiate when attempting to reap the benefits of both worlds: the local and the global. The final section summarises the argument of the paper and presents, by way of conclusion, a simple model.

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<sup>5</sup> The tendency in some contemporary writings on clusters and knowledge creation to emphasise localised learning and agglomeration factors rather than extra-local influences, that are not defined geographically, should therefore be questioned (Oinas 1999, Vatne 2001).

## **2. Knowledge creation within and across firms**

A main argument in the contemporary literature on learning and innovation is that these are the result of interactive processes in which different actors come together to collaborate in solving particular problems. While much of this literature focuses on network relations between firms, we believe that it is important to start out considering the learning process that takes place within the firm, before turning to the role of inter-firm interaction.

### *Knowledge creation within firms*

Learning within firms can take place in many different ways (Simon 1991) but is often closely related to the ongoing activities extending the existing internal knowledge pool (Fuchs 2001, Tracey, Clark and Lawton Smith 2002). A firm constitutes a common interpretative context based on the visions, values, and memories in the form of artefacts, routines and experience which help to ensure that what each employee learns is in some way connected to what the other employees might know or learn (Lawson and Lorenz 1999). But as knowledge is in itself an important source for further knowledge creation small initial individual differences increase over time even when sharing common experiences. As the firm matures its knowledge stock will, consequentially, grow in an uneven fashion and gradually become less coherent. The larger the firm becomes the fewer experiences are shared across all sections and employees and what was presumably a homogeneous initial body of knowledge becomes fragmented into a complex pattern of only partly overlapping fields of expertise, with connections and objectives no longer in full accordance with each other.

There is, of course, no fixed upper limit regarding the number of distinct fields within which a firm might maintain competencies, but the costs of mastering a broad array of different competencies often appear to outweigh the benefits (Pavitt 1999). The reason for this is that each body of knowledge, which a firm possesses, is often linked to distinct technologies and associated with the performance of certain tasks, that may require a particular set of criteria for decision-making and a specific style of management. Furthermore, each field of competence usually requires some sort of dedicated vision and targeted effort, somewhat different from the demands of all other fields of the firm's knowledge base (Loasby 2000).

*Cross-departmental knowledge creation*

The tensions of maintaining an inhomogeneous knowledge base within a single firm can, of course, to some degree be kept at bay by taking refuge to the formation of a divisionalized internal structure of the firm (Chandler 1962).<sup>6</sup> While likely to minimise the managerial ‘control loss problems’ (Teece 1980), the benefits are often obtained at the expense of the cross-divisional synergies that constituted the *raison d’être* for diversification. The ensuing difficulties in crossing departmental layers within the often large divisionalized company might at least partly help to explain the “... somewhat ironic fact that many managers consider internal transactions to be more difficult than external ones, even though vertical integration is pursued for presumed advantages” as Eccles (1983: 28) once pointed out.<sup>7</sup>

Multidivisional firms do nevertheless often have substantial advantages in being able to combine expertise from a broad range of fields. When experts from different departments get together to develop a new product, the first stage will usually involve the presentation of different types of knowledge relevant for this new development. This requires that various sources of tacit knowledge are articulated and explicated to allow for its evaluation and discussion by those who are not familiar with it. The next stage involves the re-combination and connection of the various explicit knowledge pools in such a way as to develop a new product conception. This can be done in rounds of structured discussion and brain storming. Once this stage has resulted in a new product conception, this knowledge has to be internalised (embodied) into the technical systems and employees’ routines to build and test a prototype. Finally, this tacit knowledge is constantly being transformed and perfected through processes of learning and socialising. Through this, production can be organised with lower costs over time (Nonaka and Takeuchi 1995, Lawson and Lorenz 1999).

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<sup>6</sup> See also Kie and Hynes (1996) for an empirically founded critique of the vertical disintegration hypothesis that underlies much contemporary writing in economic geography.

<sup>7</sup> This general tendency does not, of course, imply the total absence of real-life situations where horizontally- and vertically-integrated firms have outlived more specialized firms (Staber 1997).



It is obvious that the various stages in this knowledge-transformation process require different internal organisational structures to be executed efficiently (Nonaka, Toyama, and Nagata 2000). The process of articulating various types of tacit knowledge and recombining this knowledge into a new product conception might, for instance, be best organised in a project team of experts who get together for a limited time period to achieve a clearly defined goal.<sup>8</sup>

Storper (1997) argues that the goals of complex innovation processes are rarely pre-determined. They become defined through actions while the process is already underway. When faced with a major obstacle in producing a new product the participating specialists may decide to change the direction of their knowledge-creation processes by using a new material or technique developed in another line of business. The specialists may also re-negotiate their research goals and extend the group of persons that evaluate them before embarking onto the next stage. As a result of reflexive behaviour there is a constant redefinition or calibration of goals that take into account all new information about the success or failure of previous actions. Interactive innovation processes rely on relations between particular people and conventions as expressed in accepted norms, rules and practices. Even in less complex technologies, interactive learning processes across departmental borders play an important role in technological progress (Malecki 1991). The result of such interactive learning is often *incremental* rather than revolutionary in terms of technological change in product and process design.

#### *Knowledge creation across firms*

The insistence that *radical* knowledge creation is usually an interactive process across several firms emanates from recent innovation studies, but has been around for quite some time (Rosenberg 1982, Freeman 1982, 1991, Kline and Rosenberg 1986, Lundvall 1988, Håkanson 1989, Hagedoorn and Schakenraad 1992, OECD 1992, Gertler 1993,

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<sup>8</sup> Nonaka, Toyama, and Nagata (2000) use the Japanese concept of 'ba' to refer to the organisational contexts within which individuals interact at a specific time and place over a certain time period. These contexts are fluid and, due to reflexive social practices, change constantly. The existence of 'ba' allows information to be interpreted in a meaningful way and eventually results in new knowledge. In this sense, firms can be understood as dynamic configurations of 'ba'. While the concept is not restricted to intra-firm organisational contexts only it is very much associated with Japanese organizational practices. For its application in a European context, see Kostianen (2002).

1995, DeBresson *et al.* 1997). The ‘National Innovation Systems’ approach uses this insight as its most basic building block (Lundvall and Maskell 2000), but the idea that the division of labour is a device for developing knowledge is, of course, much older and constitutes the foundation for Adam Smith’s theory of economic growth, outlined in the first chapters of the *Wealth of Nations* (Smith 1776). Here, Smith (1776) identified how scientific as well as non-scientific knowledge becomes more specialised as it develops, leading to the apprehension of detailed anomalies that would else easily be overlooked and thus contributing to an acceleration of the growth of knowledge. Even when specialising in performing some particularly trivial tasks individuals find solutions and notice peculiarities otherwise overlooked. By creating an appropriate differentiation, a group of firms can therefore develop knowledge far beyond the reach of any single member of that group. With the growth of knowledge, new economic activities become possible; the economy progresses; and the resulting extension of the market makes this process self-reinforcing (Young 1928). The continual process of knowledge creation resulting from the division of labour contributes to the variation needed for future beneficial reassemble of knowledge. The division of labour among firms thus impacts directly on the (possible) level of learning in the economy.

There is, however, a flip side to the advantages obtained by the steady increase in the division of labour. The resulting dispersion of knowledge between firms also increases the cognitive distance that firms have to overcome when utilising different bodies of knowledge in their ongoing activities, particularly when they engage in inter-firm product development projects (Storper and Venables 2002). Inter-firm knowledge creation is subject to thresholds. The knowledge-bases of firms must be sufficiently different to make interaction worthwhile, hence allowing learning processes to take place. At the same time, if the cognitive distance becomes too great or the knowledge-bases too dissimilar then inter-firm learning will cease. Firms build *external relationships* when struggling to obtain a profitable balance between the two. We suspect that clustering of related economic activities may be a particularly useful strategy for striking a profitable balance. This will be dealt with in the next section.

### **3. Knowledge creation within clusters: the nature of local buzz**

In recent work, Porter (2000: 254) defines a cluster as “a geographically proximate group of inter-connected companies and associated institutions in a particular field, linked by commonalities and complementarities”, while also stating that the geographic scope of a cluster can “range from a single city or state to a country or even a group of neighbouring countries.”<sup>9</sup> This broad characterisation says, however, very little about the advantages firms have when locating within a cluster.<sup>10</sup> To answer this question one may distinguish between the horizontal and vertical dimensions of a cluster and identify the advantages of local or regional as opposed to extra-local or inter-regional interaction between firms (Maskell 2001, Malmberg and Maskell 2002, Bathelt 2002).

#### *Cluster dimensions*

The horizontal dimension of a cluster consists of those firms that produce similar goods and compete with one another. This dimension can play a decisive role in the early stage of cluster formation and specialisation. Porter (1990, 1998) has demonstrated that strong competition and rivalry between firms is an important incentive for innovation and product differentiation. These firms do not necessarily have close contacts to one another or intensive input-output relations involving substantial physical transactions. Rather, the respective firms benefit from their co-location through which they are well informed about the characteristics of their competitors’ products and about the quality and cost of the production factors that they use. Advantages of proximity thus arise from continuous monitoring and comparing. Due to their co-presence, the production conditions are basically the same for all regional firms. This enables the firms to

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<sup>9</sup> From intensive debate of Porter’s work, a number of points have been identified as being particularly problematic (e.g. Martin and Sunley 2001). One of the problems of Porter’s cluster concept is that it is remarkably imprecise with respect to the spatial scale of a cluster. Initially, Porter’s (1990) clusters are groups of interrelated national industries that are highly competitive in international markets. Later on, this concept was increasingly transferred to the regional and local level (e.g. Porter 2000). One reason why it is so easy to transfer this concept to different scales is presumably that it does not encompass internal mechanisms that explain the spatial relations and boundaries of a cluster. Some factors in Porter’s diamond are related to the regional environment, others to the national or non-spatial branch/ firm environment. A key problem is simply that Porter’s cluster concept is lacking a sound institutional framework (Bathelt and Glückler 2002). Institutions are more or less treated as residual forces that are not important in the explanation of cluster phenomena. Another problem is that Porter’s explanation is ahistorical in that it does not provide a proper understanding of the course of economic processes and their dynamics. Economic agents and their actions and interactions remain largely hidden.

<sup>10</sup> For a challenging different interpretation see Klepper (2002).

effectively compare their performance with that of their competitors. Overall, this creates rivalry and serves as an incentive for product differentiation and variation.

The vertical cluster dimension consists of those firms which are complementary and are inter-linked through a network of supplier, service and customer relations. Already Marshall (1920: 225) described the process of how variety at the horizontal level stimulates growth in the vertical dimension: “[...] if one man starts a new idea, it is taken up by others and combined with suggestions of their own; and thus becomes the source of further new ideas. And presently subsidiary trades grow up in the neighbourhood, supplying it with implements and materials, organising its traffic, and in many ways conducing to the economy of its material.” The idea behind this is that, once a specialised industry cluster has been established, the firms of this cluster develop a demand for specialised services and supplies.<sup>11</sup> This creates an incentive for suppliers to be near these firms because they form important markets. In locating close to these markets, the suppliers can gain economies of scale and distribute large parts of their production at low costs (i.e. transportation costs). As a consequence, one would expect the development of dense networks of transaction and material linkages within a cluster.

However, it has been well-known for a long time that clusters and agglomerations are seldom characterised by strong internal input-output linkages. Karaska’s (1969) classical study of input-output linkages in the Philadelphia manufacturing sector revealed that only a relatively small percentage of material linkages took place within the region. This modest importance of regional input-output linkages has been confirmed in many studies of older industrial regions (e.g. Gilmour 1974, Erikson 1975, Pred 1976), as well as high-technology production spaces (e.g. Schickhoff 1983, Chapman and Walker 1987). If it is not the cost advantage of intra-regional input-output linkages, what are then the incentives for firms to locate within a cluster and remain there?

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<sup>11</sup> Marshall's initial reflections has been followed by contributions from a vast range of scholars - from Weber (1909) to Krugman (1991, 2000) - while adding only marginally to the basic argument.

*Localised capabilities*

Recent contributions by Storper (1995, 1997), Maskell and Malmberg (1999a, 1999b), Lawson (1999) and others have pointed out that the existence of economies of scale and other kinds of traded interdependencies are simply not enough to understand the processes behind spatial clustering. In emphasising ‘localised capabilities’ and ‘untraded interdependencies’, it has been shown that socio-institutional settings, inter-firm communication and interactive processes of localised learning play decisive roles in processes of innovation and growth (Maskell *et al.* 1998, Gordon and McCann 2000, Bathelt and Glückler 2002).

Overall, the shared knowledge basis enables cluster firms to continuously combine and re-combine similar and non-similar resources to produce new knowledge and innovations. This stimulates economic specialisation within the cluster and results in the development of localised capabilities (Maskell and Malmberg 1999a, 1999b) which are available to cluster firms.

Locating within an industrial cluster has further advantages that are not available to firms situated elsewhere. Again, Marshall (1927) expressed this in his famous notion of ‘industrial atmosphere’, as being something that is ‘in the air’, limited to the people within a particular region or place. Through observations in the cutlery industry of Sheffield and Solingen, Marshall (1927: 284) concluded that such places “have acquired industrial ‘atmospheres’ of their own; which yield gratis to the manufacturers of cutlery great advantages, that are not easily to be had elsewhere: and an atmosphere cannot be moved.”

*Atmosphere, broadcasting, noise, buzz: the exclusive quality of the cluster*

Marshall’s ‘industrial atmosphere’ concerned the industry-specific cluster advantages usually referred to as ‘localisation economies’, but his general idea has lately been taken up and extended to become a more general statement about the advantages that may accrue from the geographical propinquity of industries and services in general (‘urbanisation economies’; cf. Hoover 1970). Storper and Venables (2002) have, for instance, recently identified what they see as a particularly important sub-set of urbanisation economies, which they label ‘buzz’. In a similar way, Owen-Smith and

Powell (2002) use the notion of 'local broadcasting' and Grabher (2002a) the term 'noise' to denote something similar: the idea that a certain milieu can be vibrant in the sense that there are lots of piquant and useful things going on simultaneously and therefore lots of inspiration and information to receive for the perceptive local actors. Buzz refers to the information and communication ecology created by face-to-face contacts, co-presence and co-location of people and firms within the same industry and place or region. This buzz consists of specific information and continuous updates of this information, intended and unanticipated learning processes in organised and accidental meetings, the application of the same interpretative schemes and mutual understanding of new knowledge and technologies, as well as shared cultural traditions and habits within a particular technology field, which stimulate the establishment of conventions and other institutional arrangements. Actors continuously contributing to and benefiting from the diffusion of information, gossip and news by just 'being there' (Gertler 1995).

Participating in the buzz does not require particular investments. This sort of information and communication is more or less automatically received by those who are located within the region and who participate in the cluster's various social and economic spheres. In this context, "actors are not deliberately 'scanning' their environment in search of a specific piece of information but rather are surrounded by a concoction of rumours, impressions, recommendations, trade folklore and strategic information ..." (Grabher 2002a: 209). It is almost unavoidable to receive information, rumours and news about other cluster firms and their actions. This occurs in negotiations with local suppliers, in phone calls during office hours, while talking to neighbours in the garden or when having lunch with other employees and so on. The nature of buzz is spontaneous and fluid. Co-presence within the same economic and social context generates manifold opportunities for personal meetings and communication. These meetings can be planned or occur spontaneously. They can be non-designed, non-targeted and more-or-less accidental. Hence, as pointed out by Uzzi (1997: 52), "network ties link actors in multiple ways (as business partners, friends, agents, mentors), providing a means by which resources from one relationship can be engaged for another. In investment situations, these factors increase an actor's capacity to access resources, adjust to unforeseen events, and evaluate risks." This is particularly the case in the context of a cluster which has a rich history of social interaction and

offers opportunities for multiplex relationships, face-to-face contacts and meetings. Over time, these structures of social relations stimulate fine-grained information transfer, joint problem-solving arrangements and the development of trust and reciprocity (Granovetter 1985, Uzzi 1997).

Therefore, different modes of communication operate in a cluster's social and economic context (e.g. chatting, gossiping, brainstorming, in-depth discussions, problem analysis). Co-location and visibility generate potentials for efficient inter-personal translation of important news and information between the cluster actors and firms (Latour 1986, Allen 1997). Coherence within the cluster is established by particular learning processes, path dependence, complementary resources, technological opportunities and selection environments (Murdoch 1995). This is supported by the actual movement of employees with embedded skills, which are not easily learnt, between firms (Møen 2001, Almeida and Kogut 1999, Rosenkopf and Almeida 2001).

Being located in the same place also enables firms to understand the local buzz in a meaningful and useful way. This is because co-location within a cluster stimulates the development of a particular institutional structure shared by those who participate. Firms develop similar language, technology attitudes and interpretative schemes (Lawson and Lorenz 1999). Also, as has been suggested elsewhere (Maskell *et al.* 1998), trust exists in local milieus as something inherited, that any 'insider' will benefit from by default.

#### **4. Knowledge creation across clusters: the nature of pipelines**

While a large number of studies in economic geography and related social sciences have emphasised the importance of local networking (e.g. Scott 1988, Goodman, Bamford and Saynor 1989, Saxenian 1994, Maillat *et al.* 1997, Ratti, Bramanti, and Gordon 1997) relatively few empirical studies have actually provided convincing empirical evidence of the superiority of local over non-local interaction. Actually, an increasing number of studies have begun to question the seemingly dominant character of local learning processes (Malecki and Oinas 1999, Bathelt 2001, Gertler 2001, Vatne 2001). Oinas (1999: 364), for instance, finds that "[t]here is relatively little research on 'actual

learning processes’ to give support to the claims about ‘localised learning’. As learning processes are not empirically documented, the mere agglomeration of successful firms in an industry seems to be assumed to signify localised learning.” And further, “it seems evident that the creation of new knowledge (learning) might be best viewed as a result of a ‘combination’ of close and distant interactions” (p. 365).

### *The need for pipelines*

Owen-Smith and Powell (2002) use the term ‘pipeline’ to refer to the channel used in such distant interactions. They conclude from their study of the Boston biotechnology community that even though knowledge spillovers may be more effective within a regional network than across its borders, physical distance is not the only influence. Decisive, non-incremental knowledge flows are often generated through ‘network pipelines’, rather than through undirected, spontaneous ‘local broadcasting’. Utilising this concept Owen-Smith and Powell (2002) have shown in the case of the Boston biotechnology industry that access to new knowledge does not just result from local and regional interaction but is often acquired through strategic partnerships of inter-regional and international reach. Boston’s biotechnology firms are thus not only embedded in regional innovation networks but also in social networks which are not defined geographically.

Once a potential partner from the outside has been found, it has to be decided how much information should be given to that partner and to which degree the activities of that firm have to be monitored or controlled. The resulting interaction is thus greatly impacted by the degree of trust that exists between the firms. Unlike in the case of local relations between cluster firms (Maskell and Malmberg 1999a), there is no shared trust in this situation from which the new partners can benefit. Instead, the establishment of global pipelines with new partners requires that new trust is being built in a conscious and systematic way. This process of building up trust takes time and involves costs (Harrison 1992). Lorenz (1999) has pointed out that this can be accomplished through a set of procedural rules involving a sequence of transactions and interactions wherein small risks are followed by larger ones and commitments progressively increase.<sup>12</sup>

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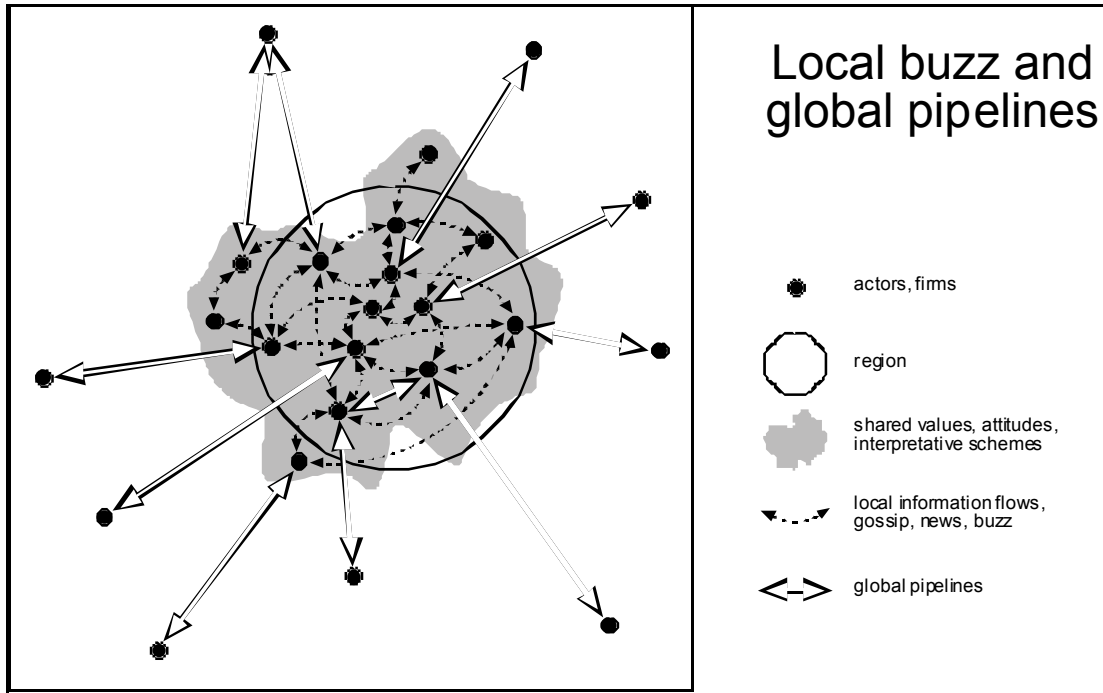
<sup>12</sup> In a case study of the restructuring in the Lyon machine-building industry, Lorenz (1999) shows how trust can develop through such procedural rules between producers and suppliers as a consequence of learning.



Now, one could indeed argue that the extra-local knowledge flows (through the pipeline system) are not dependent on the local buzz. On the contrary, it seems reasonable to expect that the two are mutually reinforcing (figure 1). The more firms of a cluster engage in the built-up of trans-local pipelines the more information and news about markets and technologies are ‘pumped’ into internal networks and the more dynamic the buzz from which local actors benefit. Because of their potential to intensify local interaction, global pipelines support a cluster’s cohesion and strengthen the internal power relations and translation processes between cluster actors (Murdoch 1995).

Maillat (1998) joins the call for actors in a local milieu to establish systematic linkages with external information sources to maintain the flow of important information about market trends and new technologies into the milieu (Crevoisier and Maillat 1991). Otherwise, it is claimed, a milieu runs the risk of stagnating. From a study of a larger number of industrial clusters in different parts of the world, Bresnahan, Gambardella and Saxenian (2001) have, furthermore, found that the reasons behind the establishment of a new cluster are much different from those which support the growth of an existing cluster. In their comparative study of information and communication technology clusters, they found that external effects, agglomeration factors and networking synergies did not have a large impact in the early stages of development. Instead, outstanding entrepreneurial activities, their willingness to take the risk of starting up new ventures and their ability to tap into new areas outside the established technologies and markets have been decisive for the genesis of those clusters studied. The success of these entrepreneurial endeavours largely depended on the firms’ ability to access major markets outside the cluster in their early stages. In addition, such clusters have been able to attract specialised skills from other localities and regions. According to the work of Bresnahan, Gambardella and Saxenian (2001), the openness of cluster relations and active search for large external markets is therefore key in understanding the rise of successful clusters.

Figure 1



In a similar vein, Scott (1998) has pointed out that the performance of localised production systems depends on the right mix of local and non-local transactions and that strong growth can only result if external markets are linked to the production cluster. Although they point out the importance of external linkages, Maillat (1998), Scott (1998), like many others, concentrate on the analysis of local networks and do not provide a deeper understanding of the nature of non-local linkages.

Another group of studies emphasises the need of extra-local linkages by referring to the dangers of local networks that are too close, too exclusive and too rigid. Such social relations could pose a threat to the competitiveness of a firm or a group of firms. In an empirical study of the New York textile industry, Uzzi (1996, 1997) has found a phenomenon that he refers to as over-embeddedness. He demonstrates that close social relations of suppliers with their local customers are only positive to a certain extent. The stronger a large group of suppliers is embedded with the same set of customers, the more likely are firms to fail. From a different point of departure Burt (1992) emphasises the importance of those actors which are able to make connections between otherwise remote networks. These are non-redundant linkages which bridge 'structural holes'. He

refers to these network relations as ‘plumbing’ through which information and resources are being transmitted. Kern (1996) emphasises that attempts to consciously open network relations for the influx of external information, as well as maintaining a certain amount of distrust with respect to traditional solutions, is important to avoid lock-in, while Malecki (2000) draws attention to the significant difference between ‘introvert’ and ‘extrovert’ firms. Even if a firm over time achieves a sufficiently successful balance between being too much inward- or too much outward-looking it is nevertheless only able to handle a limited number of external linkages, as Grabher (2001, 2002b), for instance, observed when studying London’s advertising industry. This is because the establishment and maintenance of external linkages requires substantial time and efforts. They are not created automatically and do not continue to exist without regular communication and interaction.

Overall, communication processes in global pipelines are contingent by nature and are plagued by great uncertainty. Common institutions are established that enable co-operation in particular projects. Because global pipelines encompass firms from different parts of the world which are embedded in different socio-institutional and cultural environments they operate in multiple selection environments (Owen-Smith and Powell 2002). This is particularly important in innovative industries where leading-edge knowledge constantly changes and new and better products and processes evolve. It enables local actors to choose between different technological and organisational options and select those which are robust towards changes in the institutional settings.

Thus, it can be hypothesised that both local buzz and global pipelines offer particular, albeit different, advantages for firms engaged in innovation and knowledge creation.<sup>13</sup>

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<sup>13</sup> One could argue that the buzz-and-pipeline argument carried out in this paper is at odds with Granovetter’s (1973) classic work on the strength of weak ties. Therein, Granovetter (1973) has illustrated that strong ties are rarely able to bridge the gap between different networks. He points out that particularly weak ties are able to bridge the gap between networks and, thus, allow one network to source new knowledge from another. We do not intend to imply that weak ties are dominant at the local level, while strong ties dominate the global. In accordance with Granovetter (1973), we suggest that weak ties at the periphery of a network are especially important for the diffusion of breakthrough innovations which would otherwise be slowed down by strong ties in the network core. Of course weak ties are very important in the local buzz which characterises the communication flows between the actors of a cluster. For the same reason weak ties are also extremely important when making decisions about which outside technologies and markets to tap into and which external partners to select for pipeline investments. Such weak ties are, for instance, established through conventions and trade fairs where technologically-sophisticated and dynamic international firms communicate over a limited time period.

Local buzz is beneficial to innovation processes because it generates opportunities for a variety of spontaneous and unanticipated situations where firms interact and form interpretative communities (Nonaka, Toyama, and Nagata 2000). The advantages of global pipelines are instead associated with the integration of multiple selection environments that open different potentialities and feed local interpretation and usage of knowledge hitherto residing elsewhere. Malecki (2002) concludes this line of reasoning when stating that “[S]ome places are able to create, attract, and keep economic activity ... [particularly] because people in those places ‘make connections’ with other places ...”

### *The limitations to pipeline formation*

Tapping into an external pool of knowledge and establishing new relations with distant firms requires conscious efforts.<sup>14</sup> In contrast to the type of communication and interaction that often occurs within the cluster, cost-considerations tend to make the knowledge flows and interaction in global pipelines targeted towards a certain, often pre-defined goal. As a consequence, they are usually more focused and narrow. Unlike the local buzz, information flowing through global pipelines has an intrinsic bias towards filtering information of failures even when knowledge of what went wrong could be highly useful.<sup>15</sup> Furthermore, knowledge flows through pipelines are not automatic and participation is not free. The processes behind the establishment and maintenance of global pipelines must be pre-designed and planned in advance, and they require specific investments. This involves a complex and costly process. One of the first decisions to be made here is the selection of external partners. This is not easy because information about the set of potential partners is usually truncated and the knowledge of these firms and their actual capabilities incomplete (Malmgren 1961). The partners on both ends of a global pipeline have to develop a joint interpretative context in order to engage in interaction. Firms have to be able to understand different

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<sup>14</sup> Of course we are aware that pipelines may also develop within a firm’s vicinity with nearby partners.

<sup>15</sup> In contrast with the information flows in global pipelines, the local buzz spreads information of both the successes and failures of other actors and their projects. To go beyond the regional cluster and engage in global pipelines is, to some extent, more risky because information flows about other firms are biased towards successful endeavours at this level and tend to overlook the not-so-successful. It is especially the outstanding successes which make their way through global communication channels.

institutional regimes in order to communicate and interact with actors in other parts of the world through global pipelines (Owen-Smith and Powell 2002). This requires complex capabilities. In fact, it is quite possible that through a lack of understanding of different institutional contexts communication might be almost impossible. In this case, firms would continue ‘speaking different languages’. It would be impossible to translate messages between these institutional contexts and to establish common interpretative schemes.

Since the establishment of a pipeline is a conscious attempt to overcome identified shortcomings in the local knowledge base and fulfil certain goals and expectations, actors are also prepared to make special efforts to bridge cognitive distance. While interaction between the actors on both ends of the pipeline requires that the actors have some mix of similar and non-similar knowledge (Nooteboom 2000, Nonaka, Toyama, and Nagata 2000), we may assume that this particular mix of knowledge has a different structure than that enabling local buzz (Lawson and Lorenz 1999). It seems particularly important in the selection of external partners that the degree of overlap in capabilities and knowledge assets is not too great. The lower threshold to establish such a relation is most likely the existence of a minimum amount of non-similar knowledge. Only in this case will the necessary investments to create the new relation be justified.

#### *Absorptive capacity*

Identifying the value and location of external knowledge and building pipelines to access that knowledge is, however, only part of the challenge when attempting to boost a firm’s innovative capability. An equally immense task is to establish the ability to assimilate the information arriving through pipelines and to apply it successfully towards commercial ends. Cohen and Levinthal (1990) have labelled this ability a firm’s ‘absorptive capacity’.<sup>16</sup>

Based on a careful scrutiny of a number of empirical studies concerning the cognitive basis for an individual’s absorptive capacity – including prior related knowledge and

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<sup>16</sup> Tine Aage (2001) appears to be the first who introduced the literature of absorptive capacity in the context of industrial districts while independently pursuing a similar line of investigation. See also Giuliani (2002).

diversity of background – Cohen and Levinthal (1990) specify how a firm's absorptive capacity is more than the simple sum of that of its individual employees and managers. It depends on the firm's direct interface with its local environment and on the number and extent of its pipelines. It also depends on the way in which information can be transferred across and within departments and sub-units which may be removed from the point where the pipelines enter into the firm. The role of internal gatekeepers and boundary-spanners becomes crucial for translating externally produced knowledge into a form that can be internally understood by the departments or individuals for whom it is particularly valuable. In this sense absorptive capacity can be seen as a mediating variable between the firm's environment and its organisational adaptation (van den Bosch, Volberda and de Boer 1999).

Firms build pipelines to access knowledge that is not already part of their repertoire. Yet if too different from the present mental representations, genuinely new knowledge may easily be ignored or treated as something unique and therefore not taken seriously enough (Durham 1991, 1992). The concept of absorptive capacity emphasises both the role of diversity of expertise and its distribution within the firm for creating new mental maps which integrate new knowledge arising outside the firm. Both aspects influence the aptness to cope with knowledge that cannot easily be broken down into separate pieces to be processed by a clearly defined organisational hierarchy. The distribution of expertise also affects how knowledge, which arrives through the pipelines and is dispatched by the local gatekeepers, will be understood and handled by the individuals who receive it in the various departments and sub-units of the firm. The background knowledge which is required by the group of employees as a whole when aiming at maximising the value of information consists of shared language and symbols. But if all individuals in the firm share precisely the same specialised language and symbolic representations they will not be able to tap into diverse external knowledge sources even if the relevant pipelines were in place.

Therefore, a strategy which aims at developing a coherent internal knowledge base to cope efficiently with acknowledged problems bears the risk of having too little heterogeneous knowledge to be able to fully understand and take advantage of knowledge available through the pipelines. Cohen and Levinthal (1990) refer here to Simon's (1985) famous statement that diverse knowledge structures which coexist in

the same mind elicit the sort of learning and problem solving that yields innovation. “So while common knowledge improves communication, communality should not be carried so far that diversity across individuals is substantially diminished” (Cohen and Levinthal 1990: 134).

Yet, attempts to hold many bodies of knowledge within a single firm may lead to divergent objectives, conflicting norms, or deviating visions that hamper rather than strengthen the prospects of the firm, as argued in section two above. The resulting tension between many co-existing bodies of knowledge within the same firm might also have negative effects on the firm’s general learning abilities and may also suppress external contacts which are necessary for such growth as Loasby (2000) has pointed out.

So while a firm's absorptive capacity might be enhanced through diversifying its internal knowledge base some knowledge overlap is essential for transmitting information between individuals and across sub-unit borders and for ensuring a sharing of objectives that will make the individual parts of the firm move in largely the same direction.

This analytical framework can be given a dynamic twist when investigating the reasons behind historical and path-dependent differences in firms’ innovative performance. Low investments in some area of expertise may restrict the future development of a technical capability in that area precisely because it leaves the firm without the essential tools to assimilate and employ potentially valuable knowledge in a commercially successful way which resides elsewhere and is readily available through pipelines.

##### ***5. A buzz-and-pipeline model of cluster competitiveness: concluding discussion***

We can now sum our argument in terms of a number of points which form an embryonic knowledge- and learning-centred theory of clustering. This aims to explain why firms can gain competitive advantage by being co-located in a cluster with many other firms and organisations which are involved in similar and related types of economic activity.

The basic argument should be obvious: the existence of local buzz of high quality and relevance leads to a more dynamic cluster. In this case it is beneficial to be surrounded by other actors with relevant similar and non-similar skills and competencies. These actors and their buzz are, however, of little relevance if firms are not ‘tuned in’. In order for the buzz to be valuable, it has to be comprehensible and include enough useful information. It is likely that a milieu, where many actors with related yet complementary and heterogeneous knowledge, skills and information reside, provides a perfect setting for dynamic interaction.

The second argument addresses the role of extra-local sources of knowledge, i.e. the pipeline structure. A well-developed system of pipelines connecting the local cluster to the rest of the world is beneficial for the cluster firms in two ways. First, each individual firm can benefit from establishing knowledge-enhancing relations to actors outside the local cluster. Even world-class clusters cannot be permanently self-sufficient in terms of state-of-the-art knowledge-creation. New and valuable knowledge will always be created in other parts of the world and firms who can build a pipeline to such sites of global excellence gain competitive advantage. Second, it seems reasonable to assume that the information that one cluster firm can acquire through its pipelines will spill over to other firms in the cluster through local buzz. Our hypothesis therefore is that the more developed the pipelines between the cluster and distant sites of knowledge, the higher the quality (and value) of local buzz benefiting all firms in the local cluster. This is why a firm will learn more if its neighbouring firms in the cluster are globally well-connected instead of being more inward-looking and insular in their orientation.

The third argument highlights the intrinsic trade-off between a too much inward-looking and a too much outward-looking organisational structure. In the first case knowledge is easily transmitted throughout the firm, but new external knowledge sources can be difficult to comprehend. In the latter case the external information can be understood and translated by the gate-keepers, but the internal communication gaps may prevent it from reaching the units where it could be transformed into commercially useful knowledge. However, if the buzz is sufficiently intense some such derelict knowledge may come into productive usage anyhow through highly informal channels of communication using unconventional interpretative schemes. Some may even spill over and become unravelled and applied by other firms in the cluster without the initial



receiver ever benefiting from the particular transfer. The investments needed in other settings for building an appropriate receiving capacity for deciphering and restructuring knowledge coming through the pipeline will thus, at least in part, be substituted by the free benefits of the buzz for firms located in clusters.

The forth and final argument of the model is that there are limits to the number of pipelines that an individual firm can manage simultaneously. One could hypothesise that a large number of related independent firms in a cluster can manage a larger number of pipelines than one single large firm alone. If this is true, this could provide a possible explanation why spatial clustering gives rise to competitive advantage. This would also help to explain why a cluster of many firms is better than a one-company town in terms of long-term competitiveness.

One problem with the set of propositions made above is that they do not include any notion of an upper limit to the benefits of spatial clustering. The larger the number of similar and related firms in a spatial cluster, the more vibrant and valuable the local buzz; the more firms, the greater the potential for well-developed global pipelines; the more well-developed these pipelines, the more refined the buzz. Could we think of countervailing forces which limit the benefits of spatial clustering? In this case the above hypotheses would have to be modified in such a way that a balance between vibrant buzz and information overload or between global openness and internal coherence is possible.

One such countervailing force could be that of buzz congestion. Can a cluster become so over-crowded so that there is too much buzz? Then it would be difficult for an individual actor to make sense of the buzz and identify important information. Can a firm – or rather the individuals within a firm – located in an extremely ‘buzz-intensive’ cluster begin to suffer from information overload or information fatigue-syndrome, as this situation has been termed. Information overload is believed to induce psychological, physical and social problems which show up in a lack of direction, absence of a common interpretative framework, paralysis of analytical capacity, ongoing search for more information, increased anxiety and poor decision-making (Buchanan and Kock 2001). Goulding (2001) argues that those being exposed to information overload are at risk of suffering the same fate as the information poor. The

information-poor actors are unable to take action because they do not have that information necessary to enable them to act efficiently. The information-rich actors are also paralysed simply due to their inability to create order and attach meaning to the buzz around them. The paradox is that although there is an abundance of information from which it is difficult to obtain useful, relevant information when needed.

Information overload is usually discussed in the context of developments in media and information and communication technologies or with problems facing managers in certain situations (Penrose 1959). Solutions put forward to reduce such overload often include the use of various types of filters to separate important and relevant information from irrelevant, unclear and inaccurate fragments of information (cf. Edmunds and Morris 2000). The selection is effected through discriminative attention processes (Witt 1999), based on the common cognitive frame developed over time among the firms in the cluster. Knowledge that have passed this cognitive filter is evaluated every time it is used by critical local actors. Unreliable or otherwise low-quality knowledge tend to be weeded out before it enters into general usage. Even though a vibrant cluster may be a stressful place in many ways, it can thus be argued that it also functions as an efficient information-filter and -management structure. In a cluster, information is constantly being evaluated, compared to existing knowledge and tested out. The advantage of local buzz is that each piece of information which is transmitted face-to-face has already been tested for relevance and customised to the receiver. Information overload would, thus, normally not be a major problem in the context of local buzz.

Another possible countervailing force revolves around the relation between well-developed pipelines and the quality of the local buzz. While external linkages can support regional growth processes, when they are too strong they could threaten the long-term existence of a cluster. Strong external linkages could then provoke segmentation among the members of a cluster, reducing its coherence and threatening its long-term future (Bathelt and Taylor 2002). The argument here is that when actors focus primarily on external linkages global pipelines begin to dominate the local milieu. Therefore, less attention is being paid to local communication and information flows and people are less interested to participate in local broadcasting. As a consequence, the local buzz becomes quieter and the reasons for firms to locate and remain in the cluster evaporate. Such 'hollow clusters' might not survive in the long-term as firms eventually

shift to other locations. This risk is, however, partly kept at bay as there is likely an upper limit to the number of pipelines one individual firm can manage. In addition, the low costs and automatic nature of the local buzz serve as a self-preserving mechanisms. Still, this danger is real. A cluster which is more or less empty because its important actors are constantly travelling the world in order to build and maintain an extensive pipeline system will of course run an obvious risk of becoming less vibrant.

Our final comments are directed towards the policy implications of the line of argument developed in this paper. Policy ambitions and initiatives to build, support and develop spatial clusters of similar and related economic activity have been abundant in recent years, in the OECD world and beyond. The majority of such efforts are directed towards encouraging and developing mechanisms that promote the potential for interactive learning and knowledge creation across firms and other organisations within a spatially defined cluster. The arguments put forward in this paper partly question such initiatives. The local buzz is certainly dependent on particular local institutional preconditions but the important point is that it largely takes care of itself. If a number of actors are placed within a region some sort of buzz will automatically result (even in prisons, where the inmates are kept apart from one another in order to limit information spill-over, a lot of buzz occurs). In contrast, it is especially the development of global pipelines which requires institutional and infrastructure support. Perhaps it would be wiser for policy actors to consider the possibilities of stimulating pipeline development rather than to make extensive efforts in generating and promoting local buzz through various forms of social engineering.

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# Danish Research Unit for Industrial Dynamics

## *The Research Programme*

The DRUID-research programme is organised in 3 different research themes:

- *The firm as a learning organisation*
- *Competence building and inter-firm dynamics*
- *The learning economy and the competitiveness of systems of innovation*

In each of the three areas there is one strategic theoretical and one central empirical and policy oriented orientation.

### ***Theme A: The firm as a learning organisation***

The theoretical perspective confronts and combines the resource-based view (Penrose, 1959) with recent approaches where the focus is on learning and the dynamic capabilities of the firm (Dosi, Teece and Winter, 1992). The aim of this theoretical work is to develop an analytical understanding of the firm as a learning organisation.

The empirical and policy issues relate to the nexus technology, productivity, organisational change and human resources. More insight in the dynamic interplay between these factors at the level of the firm is crucial to understand international differences in performance at the macro level in terms of economic growth and employment.

### ***Theme B: Competence building and inter-firm dynamics***

The theoretical perspective relates to the dynamics of the inter-firm division of labour and the formation of network relationships between firms. An attempt will be made to develop evolutionary models with Schumpeterian innovations as the motor driving a Marshallian evolution of the division of labour.

The empirical and policy issues relate the formation of knowledge-intensive regional and sectoral networks of firms to competitiveness and structural change. Data on the structure of production will be combined with indicators of knowledge and learning. IO-matrixes which include flows of knowledge and new technologies will be developed and supplemented by data from case-studies and questionnaires.

### ***Theme C: The learning economy and the competitiveness of systems of innovation.***

The third theme aims at a stronger conceptual and theoretical base for new concepts such as 'systems of innovation' and 'the learning economy' and to link these concepts to the ecological dimension. The focus is on the interaction between institutional and technical change in a specified geographical space. An attempt will be made to synthesise theories of economic development emphasising the role of science based-sectors with those emphasising learning-by-producing and the growing knowledge-intensity of all economic activities.

The main empirical and policy issues are related to changes in the local dimensions of innovation and learning. What remains of the relative autonomy of national systems of innovation? Is there a tendency towards convergence or divergence in the specialisation in trade, production, innovation and in the knowledge base itself when we compare regions and nations?

### **The Ph.D.-programme**

There are at present more than 10 Ph.D.-students working in close connection to the DRUID research programme. DRUID organises regularly specific Ph.D-activities such as workshops, seminars and courses, often in a co-operation with other Danish or international institutes. Also important is the role of DRUID as an environment which stimulates the Ph.D.-students to become creative and effective. This involves several elements:

- access to the international network in the form of visiting fellows and visits at the sister institutions
- participation in research projects
- access to supervision of theses
- access to databases

Each year DRUID welcomes a limited number of foreign Ph.D.-students who want to work on subjects and projects close to the core of the DRUID-research programme.

### **External projects**

DRUID-members are involved in projects with external support. One major project which covers several of the elements of the research programme is DISKO; a comparative analysis of the Danish Innovation System; and there are several projects involving international co-operation within EU's 4th Framework Programme. DRUID is open to host other projects as far as they fall within its research profile. Special attention is given to the communication of research results from such projects to a wide set of social actors and policy makers.

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