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Global Pipelines and Diverging Patterns of Knowledge Sharing in Regional Clusters[1]

1. Introduction

Knowledge and flow of knowledge has over the last decades become perhaps the most central feature of modern global capitalism. In light of an allegedly increasing global and free flow of knowledge across any boarders, it seems like a paradox however, that we are witnessing increasing geographical concentrations of asset augmenting and asset exploiting activities – referred to as the paradox of "sticky places within slippery space" (Dunning 2000: 198). As the core competencies of firms become more knowledge–intensive and mobile across space, the more the choice of location in the production, organisation and use of those assets is becoming a critical competitive advantage (ibid).

Historically, there has been a major shift in the main sources of wealth from natural assets, to tangible assets and to intangible assets, notably knowledge and information. Estimates show that in the US manufacturing industry in the 1950s, 80 per cent of value added was represented by primary or processed foodstuffs, material and mineral products, and 20 percent knowledge. By 1995, the figures had changed to 30, respectively 70, per cent. Recent calculations indicate that for most organisations like multinational corporations, the ratio of their intellectual capital to that of their physical and financial capital is between 5 to 1 and 16 to 1. Between 1975 and 1995, the expenditure on all kinds of research and development in the OECD economies had soared three times the rate of output in manufacturing industry in those countries (Dunning 2000: 200).

Assets are growingly seen as both increasable and mobile, which means that cross border augmentation of assets through Foreign Direct Investments (or FDI) or strategic alliances are steadily more important means of creating larger revenues. Knowledge is different from other forms of capital. It is a heterogeneous commodity and can be put to multiple uses as different kinds of knowledge needs to be combined with several other kinds to make a product, a good or a service. As observed by Dunning (2000), the intellectual

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capital needed to achieve that is rarely a property of one firm, and for a firm to increase its knowledge it will often have to access external knowledge by the way of some forms of collaborative agreement. This trend is furthered by the fact that in the new knowledge economy, knowledge may be expensive, risky to apply and quickly obsolete (see also Smith 2002: 7). These risks may be reduced when you get partners or decide to operate in special environments in order to access knowledge. Hence, an expanding pattern of alliance capitalism through stakeholders' co–operation, intra–firm co–operation and inter–firm collaboration has been observed across national boarders as well as within geographical concentrations of firms. In fact, the growth of the knowledge economy has led to en explosion of inter–firm alliances. And no doubt multinational corporations (or MNCs) play a central role in globalisation of knowledge flow as well as in clustering of economic activity (Dunning 2000: 195–208, Claes et al 2006: chapter 8).

It is, furthermore, argued that where clustering of economic activity will take place will depend on national and micro–regional specific characteristics. Dunning (2000) has hypothesized that the grater the degree of knowledge intensity of a particular activity, the easier it is for labour to migrate across nations and regions, the lower the distance related costs, and the more firms engage in FDI and alliance related activities to augment assets, the more likely it is that expertise will be located to micro–regional economies. The more complex the knowledge firms need to access is, and the more tacit it is, the more likely it is that they will use a variety of organisational routes to tap into the clusters knowledge pool. Clustering is, accordingly, likely to be activity specific and to be most marked where the critical decision takers in firms need to be in close physical proximity to exchange, or share, tacit knowledge (Dunning 2000: 195-96, Porter 1998).

Smith (2000) addresses four conceptions of the knowledge economy that he finds disputable: firstly, the argument that knowledge is quantitatively and qualitatively more important than before as a kind of production input. Secondly, that knowledge in some way is a more important product than has hitherto been the case, thirdly that codified knowledge has become far more important as an economic component than before, and more so than tacit knowledge, and fourthly, that the knowledge economy rests to a new extent on technological innovation in ICT. The OECD, Smith says, has produced series of comparing investment in physical capital and investment in knowledge, meaning public spending on education, total R&D and software. For the OECD as a whole, physical investment is about two and a half times grater than knowledge investments as percentage of GDP. In terms of growth rates, knowledge investment is growing faster than physical investment in the USA, the Nordic

countries and France, but the reverse is the case in Italy, Japan, Australia, Belgium, Germany, Austria, the Netherlands and UK (Smith 2000: 10).

Nevertheless, and although departing from a different angle and on other empirical grounds than Dunning (2000), Smith (2002: 6) also argues that knowledge creation is an economy wide process, not dependent on R&D to the extent claimed by many authors. He argues that the concept of knowledge economy is only meaningful if it is seen in terms of widely spread knowledge intensity across all economic activities.

Many problems have been recognised, however, within this context – especially how to conceptualize and study the flow of knowledge in clusters and regions in light of globalization (Andretsh and Lehmann 2006, Steiner 2006, Gertler and Wolfe 2006, Andersen, Bøllinghof and Christensen 2006). A more consistent focus on channels and dissemination mechanisms has released new and fruitful concepts within cluster approaches. One essential channel is local buzz. Local buzz arises from physical co–presence. It incorporates both the broad general conditions that exist when it is possible to glean knowledge from intentional face–to–face contact as well as the more diffuse forms of knowledge acquisition that arises from chance or accidental meetings and the mere fact of being in the same location. Buzz is the mechanism that facilitates the circulation of knowledge inside the cluster and thus supports the functioning of networking. A myriad of contact points makes it almost impossible for firms in a cluster to avoid acquiring information.

Pipelines, on the other hand, refer to channels of communication used in distant interaction between firms in clusters and knowledge–producing centres located at a distance. The effectiveness of these pipelines, it has been argued, depends on the strength of pre–established social relationships and the quality of trust that exists between the firms in the different nodes involved. There is increasing evidence to suggest that even in the most advanced clusters a growing part of the knowledge base is not exclusively local. The emphasis in the Porter model on local demand from sophisticated and demanding customers is contradicted by a growing body of empirical and analytical research. The weight on local demand conditions holds even less when it is transferred to the regional level where the definition of the clusters' boundaries is problematic (Gertler and Wolfe 2006). Furthermore, many MNCs as well as SMEs are embedded in a variety of specialised clusters in many locations, often around the globe (Wolfe and Gertler 2003: 1078).

The relation between firm specific growth processes and local interactive learning is complex. Bathelt et al (2004) argue that a firm constitutes a common interpretative context based on visions, values and memories in the form of artefacts, routines and experiences –

ensuring collective learning within it. Since knowledge is in itself a source for further knowledge creation, small and initial individual differences increases over time when sharing common experiences, and as a consequence the firm's knowledge stock will grow in an uneven fashion and over time become less coherent. The larger the firm grows, the more complex is the knowledge management and the managing of cross–departmental knowledge creation. In fact, internal transfer and transformation of knowledge may be more difficult than managing knowledge flow through external knowledge sources.

Although MNCs can draw on expertise from a broad range of fields, a group of firms can develop knowledge far beyond the reach of any single member of the group, as the continuing process of knowledge creation resulting from division of labour contributes to the variation needed for future reassembly of knowledge. However, increasing dispersion of knowledge between firms also increases the cognitive distance that firms have to overcome when they utilize different bodies of knowledge: "The knowledge base of firms must be sufficiently different to make interaction worth while, 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 processes will cease. Firms build external relationships when struggling to obtain a profitable balance between the two" (Bathelt et al 2004: 36). Thus, globalisation and flow of knowledge through pipelines is seen as having a positive effect on regional flow of knowledge and regional sustainability due to the pressure for knowledge creation in milieus in order to sustain firm competitiveness.

While we in this way can draw a rather general picture showing growing bond between MNCs and clusters, we still know rather little about the structure of interactive learning across national or regional clusters, and how these structures may vary (Bathelt et al 2004: 33). And despite the growing literature dealing with globalisation, internationalisation and knowledge flow in clusters, that highlight the pivotal role of MNCs in different types of clusters, there are apparently few contributions that systematically view the strategies of foreign multinational enterprises and the development of, and inside, regional clusters as interdependent. This may seem like a puzzle all the time it is claimed that MNCs establish themselves in clusters in order to access knowledge, and that foreign subsidiaries located in clusters make greater strategic contributions to the parent company than subsidiaries not located in clusters (Enright 2004, Birkinshaw and Hood 1998). Enright (1998) says that subsidiaries located in clusters may exercise different roles as listening posts that gather information from the clusters and disseminate it to the parent company. Yet another role can be to supply products and activities that are best obtained in a cluster and that can be put

through the firm's existing distribution system. Finally, says Enright (1998), subsidiaries can be used to transfer skills and capabilities from the cluster to the rest of the company.

Nevertheless, even if such interdependence studies are scarce, studies that depict and analyse institutional tensions and dualities between global and local companies in clusters are even more wanted. Can micro regions or clusters that traditionally have fostered creation and flow of complex, often tacit, knowledge maintain their original competitive strength based on flow of knowledge when knowledge increasingly is disseminated even locally through global links or channels? A few recent studies have tried to address this central question. They have focused on a tendency towards diverging local and regional learning processes as firms and organisations are increasingly exposed to internationalisation and globalisation (De Martino et al 2006, Asheim and Isaksen 2000, Asheim and Herstad 2003). They address sub–processes within the broader movements of globalisation and internationalisation that evolve when incoming MNCs are buying up innovative local firms, or conversely, when local firms become MNCs themselves through foreign direct investments (Asheim and Herstad 2003: 203). Several studies have indicated that within the industrialised world, most MNCs have established themselves as leading participants in regional knowledge–intensive clusters (De Martino et al 2006:2, Dunning 2000: 198, Claes et al 2006).

A number of specific sub-themes within a wider set of questions fostered by globalisation have also recently been set forth by for example Wolfe and Gertler (2003: 1071) and De Martino et al (2006: 15): What role do local institutions and actors play in transition processes to more knowledge intensive forms of production? How dependent are local firms on unique local knowledge assets and what is the relative importance of local versus non–local knowledge flows between economic actors? Is it so that companies that are units of larger companies tend to be more internationally oriented? What happens when companies have been purchased by out of town companies? Is it true that, all in all, local or global firms in clusters with outside operations are, as a group, less embedded within the regional cluster than those lacking external activities? Are firms acquired by outside MNCs also less inclined to interact with the local community? Is there a correlation between the degree of firms increasing organisational capabilities as they mature, spurred by inwards or outwards internationalisation, and lessened reliance on cluster relations? When elements of local value chains become part of global corporations' value chain, will this further even more lessened local reliance? How do the form of acquisition and degree of subsidiary autonomy matter? (De Martino et al 2006:16).

Micro regional sustainability based on localised knowledge flow in global capitalism is the overall theme of this paper. How can we, based on current literature, approach both the mechanisms through which globalisation of knowledge flow works in micro regions or clusters as well as assessing the effects of globalisation on micro regional economic milieus? The thesis of the paper is; that at the same time as global actors are present in clusters to a new extent and add new sources of knowledge to the clusters, their presence is challenging the established flow of knowledge and the institutional structures that facilitate this flow. Two aspects seem interconnected: MNCs may operate on more ad–hoc basis to ripe the benefits of knowledge spill–over than they engage in regional building of institutions, and they may alter power relations in regional networks consequently fostering asymmetries in knowledge flow and knowledge sharing within clusters (Christophersen and Clark 2007).

According to Andersen, Bøllingtoft and Christensen (2006: 5), recent research on cluster dynamics have embarked on three quite distinct routes. They see the industrial district literature as one distinct track, and Porter–inspired studies as another. Thirdly, they address a distinct Scandinavian track, summarised and pin–pointed by Malmberg and Maskell (2005) who emphasise the persistence of clusters as localised learning economies even in a more global economy. Additionally, say Andersen et al (2006), one particular route has emerged in two directions that emphasise the interplay between MNCs and clusters. One particular trend focuses on the role of subsidiaries in clusters (referred to are Forsgren et al 1996, Lorentzen and Manhke 2002, Andersen and Christensen 2005) and another sub-route focuses on how the MNCs organising of global value chains interact with and affect cluster dynamics (referring to Gereffi 2003, Enright 2000, Christensen and Munksgaard 2001). Such studies are, nevertheless still scarce, even more so when it comes to relations between global production networks and cluster–based production networks (Andersen et al 2006: 6).

Some scholars have recently drawn the attention to the fact that steadily more of knowledge exchange even in clusters flows through global channels and networks (Andersen, Bøllingtoft and Christensen 2006). They study cluster dynamics in light of “transformation pressures”. They note that more than traditional internationalisation, globalisation exposes all economically related activity in clusters, not the least including knowledge sharing, to a new extent. Such activity is increasingly attached to tightly woven and global production networks, market networks and knowledge networks. Consequently, they say, we are witnessing a more penetrating institutionalisation of new forms of collaboration and new managerial solutions and perspectives than ever before (Andersen et al 2006: 9).

When, for example, international companies establish subsidiaries or other functions as end users of local products in a local cluster, the flow of knowledge may be affected by the perspectives of the global actor. Andersen et al (2006: 10) for example draw attention to the presence of larger fashion houses in the shoe district in Italy. Trough control over design and distribution they affect the balance between competition and cooperation among actors in the cluster. In general, Andersen et al (2006: 13) conclude that global corporations necessarily establish activity in clusters based on their own corporate managerial and administrative models. Subsequently, these models cannot be disregarded altogether in interaction with cluster based firms. On the other hand, also local firms may loosen their bonds to the cluster, since knowledge production and dissemination is not so much linked to physical or structural capital (like certain production facilities) as has been hitherto the case. For example, one can operate a world wide logistics service cluster based firm or a design firm with clients around the world without being directly involved in any production activity (Andersen et al 2006: 16). Smith (2002: 5) in a similar vein launches the concept "distributed knowledge bases" that have "a systemic and institutionally diffuse location".

Table 1: Globalisation as transformation pressures

Transformation pressures' sources	**Transformation dynamics in clusters**	**Transformation processes' outcomes**
End users pressure Suppliers pressure Competition pressure Technology pressure Ownership pressure Standardisation pressure	Global positioning Global divergence vs. local coherence (convergence) Institutionalisation of new organisational models or forms, competences and roles Innovation, implementation and rivalry	Fragmentation and dissolving of clusters Developing a more specialised production cluster Developing a cluster consisting of specialised competences Developing a knowledge– and science based cluster

Source: Based on Andersen et al 2006, Fig. 2 p. 9 (the author's translation)

We will address these questions in the following vein: the paper seeks to explore regional convergence, or mechanisms that foster inclusion of incoming global actors or MNCs in the regional flow of knowledge. The convergence story is based on a number of Porter–inspired studies from a world leading regional cluster in its field, namely the maritime cluster in Møre and Romsdal in Mid Norway (Hervik et al 1998, 2003, 2004, 2006). The paper then explores possible mechanisms that may lead to divergent learning processes and asymmetries in

regional flow of knowledge by confronting the regional and national Porter–studies with recent international literature. The two aspects of the paper will be organised around the pipeline concept and problems connected to global pipelines working in regional clusters. Firstly, however, we need to establish a framework for the study, namely the status of knowledge flow in cluster approaches or in territorial innovation models, and subsequently the status of MNCs in clusters and how global actors may affect knowledge flow.

2. Pipelines – cluster convergent or cluster divergent knowledge flows?

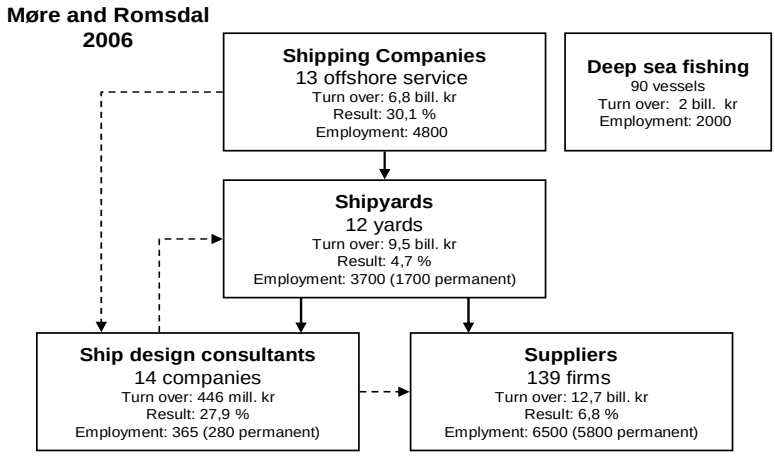
The maritime cluster in Møre and Romsdal in Mid Western Norway is not only seen as the most complete cluster in Norway, but also world wide leading in this area. Up to the present, a highly international deep sea fishing fleet has been at the core of the clustering process inside the region, and has moreover produced international success concepts for production of factory trawlers, modern combined ring net and trawler vessels, vessels for automatic driven long line fishing, and supply and offshore service vessels (or Supply Vessels, shortened PSVs) for the oil industry (Bjarnar 2006, Berge 2006).

Over the last few years the cluster has witnessed a substantial internationalisation, and export has soared especially due to the PSV segment. In 2006 this maritime cluster had approximately 18 000 employees, and the value of sales amounted to 31 billion Norwegian kroner. Several survey studies have, since 1998, depicted the success of the cluster in terms of cooperative patterns and knowledge sharing, especially a tight interplay between ship owners and shipping companies, shipyards and equipment suppliers and ship design consultants (Hervik et al 1998, 2003, 2006). Especially due to the offshore service sector the region's shipyards are fully provided with ship delivery contracts at least throughout 2010. A 2006 survey (Hervik et al 2006) that concentrated on the role of the supply service sector within the maritime cluster contains data from 13 regional offshore service shipping companies (out of a national population of 25 such companies), 12 regional shipyards (out of 22 in Norway), 139 equipment suppliers and 14 ship design consultants (out of 22 on national basis). In addition the region is a national centre for the deep see fishing fleet, with ship owners operating 90 modern vessels. (Key actors and economic data are presented in fig. 1 below).

The 12 shipyards supplied new ships in 2006 valued at 8,6 billion kroner, 42 per cent of this value was attached to ships delivered to the 14 ship owners in the cluster itself that was included in the survey (vs. only 22 per cent in 2002). For these 14 companies this local supply of new ships covered over 76 per cent of their total expenditures on new ships (vs. 62 per cent

in 2002). These data indicate that the interplay and interconnectedness between shipyards and shipping companies has become even more intense over the last four years.

Figure 1: The structure of the maritime cluster of Møre and Romsdal 2066 (from Hervik et al 2006)

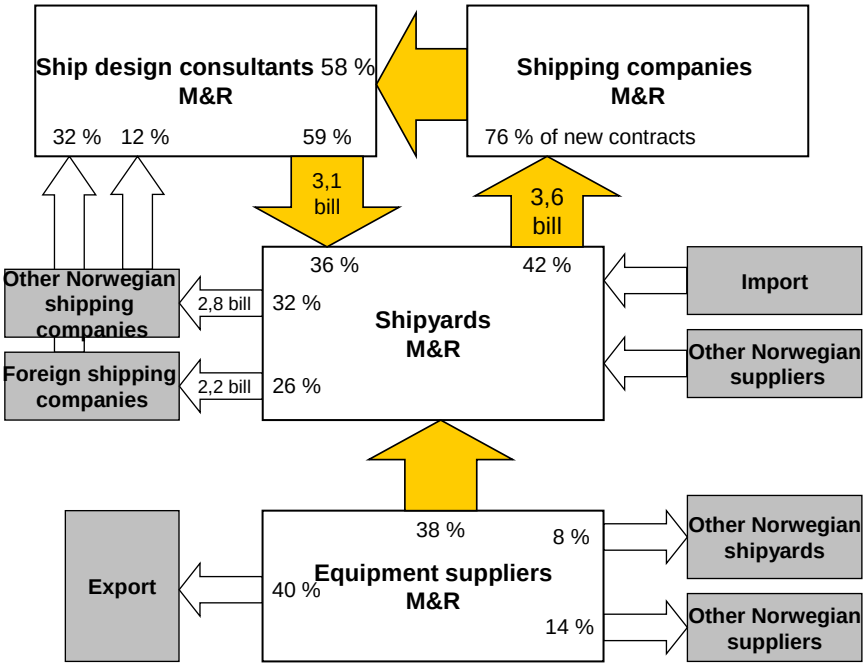


The mentioned surveys depict the ship design consultants as the main carriers of knowledge. They interact extensively with ship owners, shipyards and the supply industry following a very special pattern. They sell their design services to the ship owners. If the actual ship–owner intends to be a de facto buyer, the ship design consultants select shipyards and equipment producers that cooperate in constructing and offering a total "package" of solutions to the ship–owner based on each design. Only the design consultant thus winning the competition will have its initial costs covered by the ship–owner. They therefore act as a kind of sales corps for local shipyards and suppliers. Valued in terms of contract prices, 36 per cent of the contract assignments was generated inside the cluster by the clusters own ships consultants. This ratio has been steadily growing over the last years, again indicating that interaction between actors has been strengthened (Hervik et al 2006: 12).

The 2006 survey asked the actors how they perceived the strength of their relations to other actors, scored from one (low importance) to seven (very important). In particular there seems to be a high degree of trust attributed to the ship owners from the shipyards, while the reverse is somewhat weaker. In general there are tight relations between all the main actors; however, the equipment producers on average seem to ascribe less importance to the other actors than is the reverse pattern, but the supplier–supplier relations seem to be stronger. These findings suggest not only that there is an extensive flow of knowledge between the

actors in the cluster; it also indicates an intensified regional knowledge flow in a period when both outward internationalisation and inward globalisation in the cluster have grown rapidly.

Figure 2: Cooperative effects in the maritime cluster of Møre and Romsdal (from Hervik et al 2006)

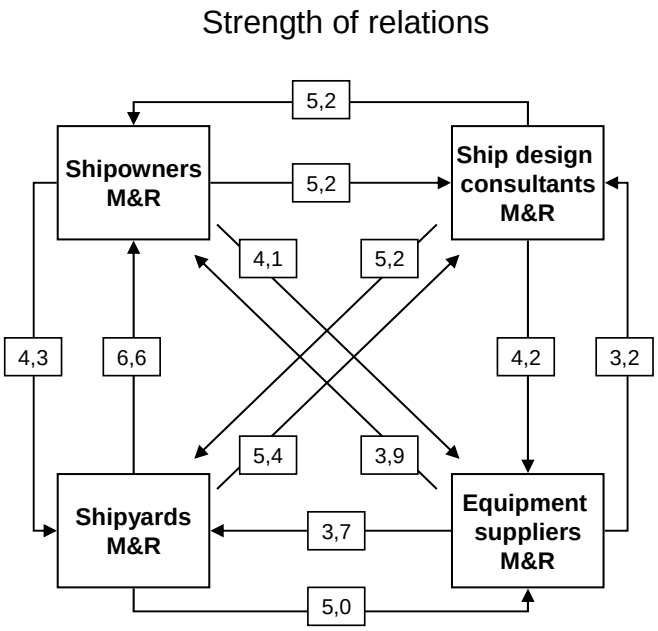


In general, the soaring demand from Asia for shipbuilding and offshore vessels has led to a growing demand for use of Norwegian shipbuilding capacity. Especially industrial growth in China has fostered a fast growing demand for ships and equipment for offshore petroleum related activities. In 2004, the world fleet of supply service vessels amounted to approximately 2000 ships, 270 of them operated by Norwegian companies. From 2004 to 2006, 25 Norwegian shipping companies contracted such vessels for a sum of 41 billion kroner, 56 per cent of these new orders were attached to companies in Møre and Romsdal. In 2004, more than 50 per cent of new ships contracted on world wide basis were ordered by Norwegian shipping companies.

In 2002 the shipyards experienced a serious crisis stemming from a too strong kroner accompanied by wage increases and a reduced state support regime. They faced declining competitiveness and loss of market shares to shipyards in Asia and Eastern Europe. Employment was reduced from 5 500 to 3 800 in 2002. The shipyards in the Møre and Romsdal cluster have, however, restored their competitiveness due to substantial investments

in modern production facilities, updated technology, upgrading competencies and building stronger and wider market networks, as well as intensified cooperation within the cluster. Also, one major reason why Norwegian shipyards are now capturing new markets and market shares is that there are 30 offshore PSV companies and an international leading milieu of ship design consultants that lead many international contracts to Norwegian shipyards.

Figure 3: Relations between actors in the maritime cluster of Møre and Romsdal (Hervik et al 2006)



Not only has the regional cluster experienced an increasing inwards internationalisation but also a stronger internationalisation of local firms. In terms of knowledge flow, recent studies have warned against this trend. Establishments abroad may lead to transfer of local knowledge from the cluster to competing actors in other countries through the setting up of subsidiaries or production units. R&D competencies and capacities can be acquired where it is best, and is not bound to Norwegian or regional institutions. The case is different when it comes to flow of local knowledge and innovative capacity, since innovation requires close interaction between institutions and end users like within the regional cluster. The challenge is depicted as follows: “For the maritime industry, the challenge will be to develop logistics where local firms may purchase products from low cost countries that may be transformed through local production to competitive products and solutions on the global market. It is the

refinement of production inside the cluster that will enable the firms to reap the benefits of global markets" (the authors' translation) (According to Hervik et al 2004: 16).

Within shipbuilding, there has been a tradition for establishing foreign operations and setting up of production abroad over many years. The use of labour from low cost countries in the cluster has also increased, although a precise statistics is lacking (Eldring 2004, Ødegård 2005). The production process is such, however, that crucial competencies are maintained in the cluster, not the least attached to flow of knowledge. Norwegian shipbuilding in general is characterised by end products (ships) that are highly individual solutions, and the low degree of standardisation also means that a lot of capital is bound to each individual product. The production process thus demands a highly developed organising and management of each process and a well developed flow of parts, knowledge and solutions throughout the process. Since a large part of the production of parts now takes place abroad, the shipyards have focused even more on effective flow of work and knowledge, and on project management aiming at improved integration and control of internal and external flow of work processes and knowledge. The shipyards own production is, besides this, largely connected to the final assembly of parts and equipment, much of the latter is still produced within the cluster. Many of the workers in the shipyards' production have work experience from the equipment supply sector or from being sailors or fishermen, and they have as such a broad and also rather specialised knowledge, formal as well as tacit, that the yards are dependent on. This local or cluster related experience based knowledge is not readily substituted by recruiting foreign workers (Hervik et al 2004: 19).

Outward and inward internationalisation has increased substantially within the shipyard sector. They build ships for customers all over the world. The cluster related competence base has proved effective also in a global setting, especially since Norwegian shipyards have been good at offering shorter production time and delivering better on schedule than their competitors. However, high internal costs and high wage levels make it difficult to maintain production capacity in Norway. Outsourcing has thus reduced production costs substantially. Most of the construction of parts (skrog) has now been outsourced to Eastern European transition economies (Thus for example Aker Yards has acquired two ship yards in Romania. Ulstein Verft has set up a branch office in Poland to manage foreign outsourced production of parts. Many shipyards have based their production of parts by contracting foreign suppliers. See Hervik et al 2004: 20). Moreover, Norwegian equipment suppliers have also established branch offices and production units abroad. And some of the

subsidiary shipyards have developed to a level that they soon may be able to produce fully equipped ships, thus providing the markets with end products.

Nevertheless, ship building is, as already mentioned not mass production, but the construction of rather unique and individual products. Moreover, it is still largely craft based production. Specific demands and specifications will be attached to each ship, and the production is very complex, involving a wide range of components, work operations, professions, suppliers and sub–suppliers etc. The production process thus may be unpredictable and demands excellence in managing it. Complicated logistics at the shop–floor level moreover require a pool of highly developed tacit knowledge. Shipbuilding has, furthermore, a "fluid" character, since the interaction between managers, workers, specialists and suppliers may vary from ship to ship. The cluster is thus to a certain extent consisting of temporary production systems.

Facilitating flow of knowledge is a growing challenge as the international competition fosters tighter delivery time schedules. Hervik et al (2004: 22) claim that "The likelihood for bottlenecks to occur due to misjudgements, errors, delays and colliding of work operations is increasing. At the same time, the mutual interdependence between flow of materials, parts, workforce and knowledge in each project is more extensive than before" (The authors' translation). The most viable strategy, according to Hervik et al (2004) is to refine the project management. Other measures counteracting both time pressure and bottlenecks in this fluid production process have been to introduce a more standardised production based on series of modules. And as already mentioned some of the shipyards have set up larger and modernised factories so that a larger part of the production and assembly process is now condensed inside one single building.

The shipyards recruitment policy has been to promote a combination of work process design and wage– and incentive systems that foster focus on responsibility, on productivity and quality, flexibility and upgrading of competencies. Norwegian shipyards are building advanced complex ships. Production– and setting up of equipment is mainly conducted by the shipyards in Norway, which demands professional workers on different shop–floor levels possessing very high technical and social qualifications. In case of increasing standardisation and industrialisation of production this may though mean higher focus on import of workers and use of foreign sub–contractors (Hervik et al 2004: 23). Whether this will imply lower or higher demands on the project organisation remains to be seen.

It appears from the above that one of the most important factors still clustering the firms on regional level is the character of the knowledge base and in particular the high

requirements posed on knowledge flows. As will be further explained, the cluster has a distinct "synthetic" knowledge base, and it seems from world wide cluster studies that maintaining this kind of knowledge base is a considerable force preventing the region from being tapped of knowledge through inward or outward globalisation. It is, simply framed, a kind of sticky knowledge, sticking to a specific geographical area. A recent study globalisation pressure of four clusters in Denmark largely confirms this picture – while production is outsourced – the knowledge intensive part remains intact in the cluster (Andersen et al 2006: 50).

The cluster is, as mentioned, seen as the most complete and comprehensive maritime cluster in Norway as well as globally leading. A basic organisational form, namely small shipping companies within deep sea fishing where the active skipper was owner and controlled strategic decisions, has been particularly important in promoting an extensive flow of knowledge within the maritime cluster. These companies have intersected experience based specialised knowledge with more formal and technological knowledge as the skipper–owners have interacted closely with shipyards, mechanical industry and producers of electronic equipment and hydraulic devices. This flow of knowledge placed the regional cluster in the international forefront. Since the 1970s, moreover, a substantial flow of knowledge to new blooming industries was facilitated, as many of the skipper–owners pioneered businesses within offshore supply services, fish farming and marine industry (Berge 2001, 2006, Bjarnar 2006).

Since the 1970s, however, the skipper–owners have been exposed to heavy national and international regulations. To some extent complicated regulations have promoted bureaucratisation of deep sea shipping companies. Advanced technological development has, furthermore, apparently increasingly replaced local or regional networks with networks stretching far beyond the region, as in particular the supply service vessel case and the shipbuilding sector, so that knowledge may be produced and accumulated more independently of the hitherto social networks. Tendencies towards ownership concentration and also geographical concentration have been witnessed, and central actors within the cluster point out that the flow of knowledge seems less free and more formalised (Johnsen 2004, Bjarnar 2006).

As proposed in the cluster debate internationalisation promotes the importance of localisation. However, if the tendencies briefly outlined above can be empirically assessed, it may be hypothesised that localisation increasingly means high local concentration of competence and capital which may foster more isolated milieus with lessened systemic

interaction with other actors in the cluster. Formalisation of knowledge flows may further accelerate such tendencies. This phenomenon has not been predicted in the cluster literature. On the other hand, the skipper–owners have demonstrated a striking ability to prevail as competence nodes in the maritime cluster. Thus, the debate on the role of globalisation in knowledge creation and dissemination would benefit from longitudinal historical studies of the effects of structural changes on flow of knowledge.

The Møre and Romsdal maritime cluster may therefore be characterised by multiple heterogeneous historical processes. It is in the first place still path dependent on an innovative economy characterised by collaborative and collective learning processes and interactive innovation. In the second place, however, we may witness the creation of new paths that may lead to higher diversity of knowledge bases and diverging learning processes diminishing the role of the traditional cluster. On the other hand, it should be of interest to scholars and practitioners in the field to pose the question whether interaction between old and emerging paths may also create new dynamic learning processes within the cluster framework.

While cluster theories may be useful in order to capture essential long term paths of flow of knowledge and industrial development, it will nevertheless be indicated that they suffer from lack of longitudinal historical studies and the focus on historical paths and how they are changing. Related to this, scholars have struggled to come to grip with how to specify as well as theorise knowledge flow. It will be argued that cluster theories should be more infused with literature on dissemination of innovations and knowledge that more specifically and more concretely has addressed the dissemination mechanisms and the historical and social construct of knowledge flow.

However, to what extent are such structural challenges coupled to outward or inward internationalisation? This has largely to do with the essential role of the fishermen and sailors as carriers of knowledge in the maritime cluster. Not only have they been essential to incremental innovation processes, but also to radical innovations, like the four global winner concepts briefly described above (Berge 2000, 2006, Isaksen 1999). In more incremental terms, the fishermen and sailors have been essential carriers on different levels. They have both conveyed experiences with operating ships and equipment under often difficult water and weather conditions, and, moreover, themselves suggested important new ideas. The current most blooming innovation within the maritime cluster, the design of the offshore supply service vessel, was induced by fishermen and materialised as a best selling commercial product via the skipper–owners (Berge 2006).

Within ship–building innovation is produced more or less constantly and incrementally at the practical level. Engineers, workers, and fishermen and sailors, discover through learning by doing new smart solutions that lead to adaptations and improvements of constructions and equipment. Due to the individuality and crafts based character of each new ordered ship, or equipment, the construction process in itself has a distinct character of at least incremental innovation. Innovative processes are also more formalised, as many of the firms invest R&D expenditures on basic testing of new materials, how to reduce weight, increase speed and reduce transport costs. Within deep sea fishing, for example, innovations partly based on experience based knowledge have led to use of new and more cost effective engines (Berge 2006, Bjarnar 2006). R&D departments within some of the companies cooperate also extensively with research institutions domestically and abroad (Isaksen 1999). However, the firms have traditionally been embedded in internal and external networks which have promoted an extensive flow of such knowledge and its intersection with the tacit knowledge carried by workers and sailors. Thus, the question has been raised to what extent the large global actors established in the region since 1990 are able to maintain this loyalty and commitment from workers and sailors, and to be parts of the social interaction that facilitates the flow of knowledge (Isaksen 1999).

The global actors have a central position in the cluster within supply of equipment (like Rolls Royce, Scana), within ship–building (Aker Yards), and within the PSV sector (Bourbon, Aries, Trieste). At least form the outset, they are as much dependent on the socially constructed flow of knowledge within the regional cluster as local actors. However, the supply sector is operating world wide, and even though much of the crew would be recruited from the region, it may be more uncertain to what extent they can be taking part in the daily local reproduction and construction of experienced based knowledge.

Furthermore, there obviously have emerged tensions and a strengthened competition between the deep sea fishing fleet and the growing PSV sector. On the one hand the deep sea fishing fleet has been substantially concentrated to a few localities, hence it is a question to what extent ship–owners and fishermen can maintain their position in the local and regional "glue" of knowledge flow. Fishing itself has also become extensively dependent on technology and science, and has been professionalized may be to a hitherto unknown degree. Reproduction or production of knowledge may be less depending on flow of knowledge through local social networks, and may be increasingly attached to stretched networks between ship–owners, equipment producers and political authorities. Some researches have

gone so far as to say that the fishery sector has been emptied of fishermen in the classical sense (Johnsen 2003, 2004).

In this sense, they may loose the importance as end users of products developed within the cluster, may be also worsened by the fact that hardly any new fishing vessels are currently contracted from regional ship–owners (Berge 2006). Instead, the present boom is created by the offshore sector. The offshore sector has hitherto been more or less fully dependent on recruiting fishermen as crew on the PSVs. But since this fishing fleet is concentrated on fewer ships and is more geographically condensed, it can hardly produce as many sailors as needed by the surging global supply companies. Or the fishing fleet may simply be loosing competitiveness to the supply sector. In case also this emerging fleet will become more dependent on recruiting sailors elsewhere than regionally, and the ships increasingly operate globally and disconnected from the regional or local reproduction, production and flow of knowledge, this may in the future turn into a vicious circle. The question is therefore actualised, whether the new global hub firms present in the region within ship–building, supply of equipment and offshore shipping will have the interest in and the capacity to counteract such alleged structural changes. This remains to be seen, and should trigger new research.

In our context, there are also some additional central problems that are not addressed in the above mentioned cluster studies. The surveys do not, in the first place, discriminate between global actors and regional actors, and cannot therefore reveal possible institutional tensions inside the cluster between global and local actors. Moreover, the relations between external pipelines as channels for knowledge flow and local channels, local buzz, is not investigated. Whether strengthened international relations contribute to closer interaction or external relations is becoming more important than local or not, can therefore hardly be derived from the actual survey. Thirdly, they do not reveal whether there is a shifting balance between the flow of tacit and formal knowledge between actors, hence there is the possibility that beneath a surface of strengthened flow of knowledge we may witness increasing formalisation of knowledge flow. Finally, the surveys do not account for structural changes, for example that competence and knowledge flow may be much more geographically concentrated than before. It has been pointed out, though, that the offshore service shipping companies contract a growing number of new specialised vessels from Norwegian shipyards and equipment supply companies, leading to strong vertical integration between Norwegian companies within offshore operations (Hervik et al 2006: 19).

In fact, the 2006 survey by Hervik et al concludes that growing foreign presence in terms of ownership, both within shipping companies and the equipment supply sector in Møre and Romsdal may indicate that the cluster has become more attractive for foreign investments and has, subsequently, grown stronger financially. Globalisation processes have been considerable in the cluster in recent years. In fact, three larger regional hub firms are engaged in foreign operations which constitute a substantial part of their activity (Farstad Shipping, Rolls Royce Marine and Aker Yards). According to Hervik et al 2004: 13; "They are emerging as more mobile and footloose actors that may routinely consider moving activities to other countries due to favourable institutional settings" (the authors translation).

Subsequently, the following parts of the paper will make an effort to go beyond the apparent convergence story of this particular regional cluster by relating it to a wider conceptual framework of globalisation and cluster based flow of knowledge, and by establishing a framework for depicting the role of incoming global actors in such clusters.

3. Globalisation and knowledge flow in clusters – a conceptual framework

Two partly contrasting approaches are cast light on in the emerging research on globalisation and knowledge flow, and may figure as a point of departure for the present study. On the one hand it is questioned whether, in light of these global movements, the importance of local contextual and tacit knowledge and the dissemination of such knowledge through regional knowledge networks is diminishing. Knowledge accumulation, accordingly, becomes increasingly independent of space. If businesses place more emphasis on seeking global formal knowledge than before, this may lead to the prominence of non–local linkages and fragmentation and deterioration of hitherto viable cluster economies in cases they are based on knowledge sharing through local social networks and institutions.

On the other hand, there is another body of arguments implying that strategic knowledge, tacit as well as codified, still is disembodied. Accumulation of tacit as well as codified knowledge depends much on localised interactive learning. Knowledge accumulation is therefore not placeless – it is both disembodied and geographically "sticky". Nevertheless, recent research indicates that as firms internationalise, intimate local relationships become less significant (De Martino et al 2006:1). The interpretation and implications of this observation is, however, by no means clear.

Apart from the fact that the modern alliance and network capitalism is increasingly spatial, why are clusters of such specific interest in light of globalization and knowledge flow? Essentially because flow of knowledge, in form of spill–over or transfer, is the core element in spatial analysis within neo–classical economics (agglomeration theories and industrial complex models) as well as in territorial innovation models developed within business strategy, sociology and economic geography, like cluster theories. And this flow of knowledge may be profoundly affected by globalisation and internationalisation.

Within neo–classical economics it has long been realised that knowledge is a key factor for determining competitiveness and economic growth, and this has lead to a stronger focus on the role of space, regions and proximity. One also observed that production as well as innovation was geographically concentrated, and knowledge spill–over figured prominently in explaining why this pattern emerged. Neo–classical economics' interest in geographical concentration of economic activity stemmed from modern trade theory and problems of spatial allocation. The development of trading blocks accelerated this interest. Together, different directions within neo–classical economics have asked why we are witnessing spatial investment patterns and whether they create economies of scale offering increasing returns (Krugman 1991, Fujita and Krugman 1995).

Within business and management literature, localisation is viewed as related to broader set of questions of constructing the optimal relation between the firm, its customer and its suppliers (Porter 1998). In economic geography one has been more focused on the spatial organisation of production (Scott 1993, Saxenian 1994, Piore and Sabel 1984) and within sociology on the role of the firm's environment, it's embedding in social networks and the role of this embedding for its performance (mentioned here should be among others Granovetter 1985, 1992, Aydalot 1986, Camagni 1995. For a useful survey of the different traditions, see Gordon and McCann 1997). The distinction between the different approaches are not at all that clear, however, and most studies reviewed here in one way or another draws upon insights from various theoretical positions.

Factors like internationalisation and growing instability in product markets, as well as intensified competition and a greater focus on quality and variety, have increased the importance of flexibility, encouraging greater reliance on external than internal economies (Gordon and McCann 2007: 514). Clusters or spatial industrial localisation may in this respect offer and represent codification schemes that manage spatially dispersed but integrated production systems. Clusters may foster core interactions between lead firms and key suppliers that for example resist easy codification, such as design, development of prototypes

and the determining of the validity of manufacturing processes. Researchers in the field have, for instance, suggested that the global leadership of the US is actually based on dynamics within large clusters (Asheim, Cooke and Martin 2006). Despite many different focuses (clusters, industrial districts, new industrial spaces, local production systems, regional innovation systems, learning regions and the like) the various territorial models claim that firms in clusters or other similar systems are linked in some more or less formal or loose way. They can formally be linked vertically through buying and selling chains, or they can be connected horizontally by use of similar inputs, technologies, services, suppliers and by producing complementary products.

These vertical and horizontal links are often embedded in close social relationships, networks and in culture (Asheim, Cooke and Martin 2006). Strong interdependencies among firms and organisations may evolve based upon sharing knowledge, for which no market mechanisms exist (Granovetter 1992). Across different territorial innovation models it is proposed that the major advantage of geographical and social proximity is increased flow of knowledge between actors in the clusters. Clusters accumulate formal and tacit knowledge which no single business can fully contain within its organisation. Accordingly, highly specialised knowledge is accessed through networking within clusters (Mouleart and Seika 2004, Asheim, Cooke and Martin 2006).

Although flow of knowledge may figure prominently in most cluster variants, it is also necessary to distinguish roughly between them in order to discover which channels, mechanisms and processes of knowledge flow is most operative in the actual cluster one would like to study in light of globalisation. Recent works have, as briefly mentioned, suggested two main approaches. The first one tends to view clusters as the product of traditional agglomeration economies. Here firms are co–located as a mean of benefiting from easier access to, and reduced costs of, certain collective resources, like a specialised infrastructure or access to a local labour market. The second one places more emphasis on the role of knowledge and learning processes in sustaining clusters. Clusters offer local flow of spatially sticky tacit knowledge. Moreover, dynamic clusters develop strong connections to other clusters through international sharing of knowledge, which also draws the attention to the need to understand how local clusters get situated within broader institutional matrixes (like regional or national innovation systems) and international hierarchies where local knowledge–bases provide only an element in more complex patterns of knowledge flows (Wolfe and Gertler 2003: 1074). Yet other recent works subsume the clustering of industrial and economic activity under three main headlines – the model of pure agglomeration, the

industrial–complex model and the social network model (Gordon and McCann 2007). These models are worth considering, since they have different implications for analysing knowledge flow in light of globalisation.

The agglomeration model emphasize that firms tend to locate in the same area due to its development of a local pool of specialised labour, increased local provision of industry specific inputs and a maximum flow of information and ideas. Geographical concentration stems from the fact that sources and benefits of this kind are not internal to any participating firm. For example can no single firm establish a pool of specialised labour as a result of a labour market system so that it maximizes the job matching opportunities between individual the workers and business. This match is collective and is a positive externality to the firms. However, "the pure model of agglomeration presumes no form of cooperation between actors beyond what is in their individual interests in an atomised and competitive environment. Profitable local interaction is made possible through a combination of chance, the law of large numbers and the natural selection of businesses benefiting from the opportunities on offer" (Gordon and McCann 2007: 517). On the other hand, such agglomerations in a collective way hedges individual firms against uncertainty. Moreover, agglomerations with their myriads of contact points are widely held to promote firm's adaptive flexibility in times of increased uncertainty and change (Gordon and McCann 2007: 517). This model has proved valuable first and foremost in analyzing urbanization of economic activity.

By contrast, classical economics has also established *an industrial complex model.* According to Gordon and McCann (2007: 518), "these industrial complexes are characterised by sets of identifiable and stable relations among firms which are in part manifested in their spatial behaviour". At the heart of this spatial behaviour are stable trading links and patterns of sales and purchases. In addition, as in the agglomeration model, spatial organisation of industry could be triggered by insights into relationships between space and industrial production, in terms of optimal relationships between location, level of transport costs and price of production factors. As many of the factors in the agglomeration model were rather difficult to identify as clearly distinct variables, these recent mentioned factors were more readily identifiable.

It is argued that all subsequent development of neoclassical location theory resides within these partly overlapping frameworks. They constitute a static model, "as the only reason why we might observe spatial industrial clustering is that the individual firms, in aiming to minimize their observable spatial transaction costs, have implicitly or explicitly determined that this is best achieved by locating close to other firms within the particular

input–output production and consumption hierarchy of which they are a part" (Gordon and McCann 2007: 519). Typical examples of such clustering are within oil refining, chemicals and pharmaceutical industrial complexes. An essential clustering mechanism is that, even though one single firm can be leading in and monopolising innovation, it is the overall organisation of the complex that monopolises the ability of the individual firm to realise the benefits of the innovation (ibid).

The neoclassical approach perceived the creation of hierarchical organisations and institutions to be a rational response to the transaction costs problems caused by bounded rationality and opportunism in a pure market–contract economy. Although operating in industrial complexes, the rational response to transaction cost would first and foremost be to internalise and coordinate resources within hierarchies. Routines, norms and contracts between individuals and the organisation were means of institutionalising trust within the organisation.

The *social network model* developed by sociologists, by contrast, argued that there was more order to inter–firm interactions than to intra–firm interactions than the economic models would imply. They observed that strong interpersonal relationships transcended firm boundaries so that many inter–firm social interactions may be stronger than their intra–firm counterparts (Gordon and McCann 2007: 520). These relations were depending crucially on trust between actors. According to Gordon and McCann (2007: 520), "Where there are relationships among individuals who have decision–making power in a group of different firms or organisations, the existence of these trust relationships will mean that the individual or collective actions of the group differ from the behaviour associated with either pure market–contracting or hierarchically organised relationships."

They highlight three key features: 1) firms within social networks are willing to undertake risky cooperative ventures without fear of opportunism, 2) firms are willing to reorganise their relationships without fear of reprisals and 3) firms are willing to act as a group in support of common mutually beneficial goals. "These behavioural features imply that the social network is comprised of a set of transitive private relationships in situations where neither price signals nor monitoring are sufficient to ensure the implementation of a particular project or activity." (p. 520). The strengths of these relationships is described as embeddedness of social networks, and in fact all economic relations are socially embedded in the sense that they depend upon norms, institutions and sets of assumptions shared among a group of actors. They are not simply the outcome of economic decisions. However, industrial clusters reflect an unusual level of embeddedness and social integration. Although there is

nothing inherently spatial about this model, it is observed that spatial concentrations of social-economic networks tend to be formed knitted to a distinctive historically evolved local economic base with long lasting and strong cultural and personal links among actors. Knowledge is therefore diffused through social relations, and the only way to access this diffusion in–depth is to be part–takers in this institution building.

It can be argued that the incentives for investing heavily in local networks must be limited in a global world where competitiveness in global markets requires a high degree of flexibility in business strategies and building partnerships to access highly specialised capabilities, a context would favour localisation within clusters mainly understood as agglomerations with a dense webs of national and international communication links. Subsequently, it is expected that concentration of investments in particular partners and strong local communities are more likely to take place where pure agglomeration economies are not available (in accordance with Gordon and McCann 2007: 521)

Nevertheless, different cluster approaches seem to share one basic observation – namely that knowledge sharing and intensified knowledge transfer are the essential mechanisms that both drive the clustering process and drive innovation inside the established cluster (Asheim, Cooke and Martin 2006. See also Malmberg and Maskell 2002. This should not, however, conceal the fact that there seems to remain a striking lack of consensus over how clusters are started and to what extent their emergence can be set in motion by conscious design or policy interventions, to paraphrase Wolfe and Gertler 2003: 1073). Joint production and transfer of knowledge is most effective among economic actors located close to each other and when it is promoted through social interaction and institution building (Wolfe and Gertler 2003: 1076). Knowledge flow is thus more than a result of co–location or physical or social proximity. It is better understood as a function of institutional proximity consisting of common norms, conventions, values and routines (Gertler 2003: 91). In this perspective, pure agglomerations ore pure industrial complexes are much more ideal type models than the social network model that seems to be somewhat closer to real world economics.

In the same vein, cluster models with no such clear core of observations, like Porter–inspired models within business strategy literature, are exposed to critical questions in light of globalisation of knowledge flow. Studies on globalisation of cluster dynamics have not only focused on the consequence of internationalisation processes for the allegedly free knowledge flow in clusters. In fact, the internationalisation focus has led to a number of basic theoretical, analytical and empirical challenges in cluster studies. The assumed paramount role of local demand and local rivalry conditions for cluster formation that figures so prominently in

Porter–inspired models is questioned. The central role of proximity is challenged, as empirical studies demonstrate that there is no automatic correlation between proximity and interaction among actors in clusters (De Martino et al 2006:8). The abstract notion of automatic knowledge spill–over in clusters is put under critique as studies of globalisation processes and the subsequent growth of non–local knowledge linkages and their interaction with clusters require specific analysis of dissemination channels and mechanisms (Asheim, Cooke and Martin 2006). The allegedly essential role of local or tacit knowledge and its diffusion is gradually downplayed. On the contrary, non–local and international links are more crucial for knowledge flows in clusters. The most successful clusters seem to be those that effectively build and manage a variety of channels for accessing relevant knowledge from global sources (Gertler and Wolfe 2006).

Moreover, significant methodological problems have been raised. How can we define, explore and test the role of local cluster linkages? In what manner is it possible to study not only formal linkages (patents, formal contacts, established supplier relationships) but also informal relationships? What types of local attributes can be attached to what types of clusters? Do actors in clusters have one unitary perception of globalisation and globalisation challenges? If cluster–based firms differ in their local relationships – will firm internationalisation impact each firm or cluster differently? (Cited from De Martino et al 2006: 9)

Some perspectives takes for granted key aspects of the Porter diamond, by assuming that firms co–located in the cluster tend to be rivals in the same product market or part of a locally based supply chain, and that close monitoring of competitors or tight buyer–supplier interaction are key elements that tie the firm to the cluster (Maskell 2001). Such cluster approaches claim that the primary reason for emergence of clusters is the enhanced knowledge creation: 1) Along the horizontal dimension where firms in clusters reduce the cost of coordinating otherwise dispersed sources of knowledge and thus overcoming the problems of asymmetrical access to information for different firms, and when easier access to monitoring and competition drives innovation, and 2) the vertical dimension, where complementary firms are interlinked through networks of supplier relations and customer relations.

This assumption, however, probably holds mostly for the more advanced and developed clusters. And relatively few clusters are self–sufficient in terms of the knowledge base from which firms draw (Gertler and Wolfe 2006). Furthermore, the role of proximity is questioned. Sheer proximity is not sufficient to account for local knowledge spill–over. The

Porter-inspired spill–over concept overlooks the broader set of factors that promote the effective transfer of knowledge in clusters, like the high level of embedded–ness in a very thick network of knowledge sharing. The degree to which firms can tap into a common knowledge base at the local level depends on more than spatial proximity, cultural affinity or corporate culture. The institutional context of the cluster defines how things are done within it and how learning transpires (Breschi and Malerba 2001, Gertler 2003, 2004).

Much of the literature on knowledge spill-over, moreover, presumes that the knowledge shared is highly technical and tacit in nature, while transfer of knowledge embodied in qualified personnel has drawn less attention. Under–communicated therefore, is how entrepreneurial skills and entrepreneurs as key agents build upon the existing base of institutional assets, and to what extent the entrepreneurs are essential for the transformation of institutional assets into clusters. Entrepreneurial knowledge can be transmitted through a variety of mechanisms, including spin–off of new firms from larger anchor firms within the cluster, the mobility of key personnel within the cluster, and the transfer through angel and venture investing (Feldman 2005). Furthermore, knowledge is diffused by peer–to–peer monitoring and knowledge sharing that is organised through local industrial and civic associations. Infrastructural knowledge resources are important.

In light of globalisation, two processes seem to run parallel, namely that competitive advantage is increasingly attached to knowledge at the expense of input of capital, labour and physical capital, and that we are witnessing a shift in emphasis from building and transferring tacit knowledge towards handling flows of codified information (Andretsh and Lehmann 2006). Recent research seems to imply that due to globalisation processes and internationalisation, an increasing need for knowledge specialisation is a driving force toward shifting the regional balance of formal and tacit knowledge in favour of formal knowledge. And as firms internationalise, intimate local relationships become less significant. Firms pursuing strategies to develop capabilities outside their home region elect to reorient their level of intra– vs. inter–cluster interaction (De Martino et al 2006). This tendency is convergent with another – namely that the interactive accumulation of tacit and formal knowledge increasingly is taking place *inside* organisations, within the embedded firm. The strength of, and the long term consequences of such tendencies yet largely remains to be historically underpinned, as well as conceptually and empirically assessed within economics or economic geography (confer Asheim and Herstad 2003). Whether this phenomenon is underpinning existing and emerging clusters or conversely, creates diverging learning

processes that in the long run have a deteriorating effect on cluster formation, is not clear from existing literature.

At the same time, new conceptual contributions to the field have begun to question the overwhelming emphasis on local interaction and knowledge circulation contained within the cluster as the main source of innovative dynamism for firms in clusters. It is argued that non-local and international links are crucial for knowledge flows in clusters. Recent research also indicates that the flow of knowledge that feed innovation in a cluster is often both local and global. Successful clusters, it seems, are as already mentioned those that effectively build and manage a variety of channels for accessing relevant knowledge from global sources (Bathelt et al 2004). Resource based approaches have combined the focus on knowledge flow with a more persistent focus on technological development. In cases where industrial production in clusters are depending on increasingly complex technologies, the production will increasingly also require the support of sophisticated organisational networks situated across a wider array of locations (Wolfe and Gertler 2003: 1077).

A great deal of confusion stems, it is argued, from the failure to differentiate between different types of knowledge. Innovation involves a dynamic interplay with and transformation of tacit and formal knowledge. However, this interplay may differ according to which kind of knowledge that characterise different clusters. A *synthetic* knowledge base dominates industrial settings where innovation takes place through novel combinations of existing knowledge. It serves to solve specific developmental challenges that occur in interaction with clients and suppliers. A classical example is an industrial structure with firms producing and applying advanced industrial, mechanical or electronics equipment.

Knowledge tends to be developed inductively more than deductively through a process of testing, experimentation, simulation and application or transformation. In those industrial structures where an analytical knowledge base dominates, knowledge creation is more deductively and rooted in formal models and codified scientific knowledge which is applied through a more rational process. It has been, accordingly, hypothesised that localised learning and knowledge flows are more important in synthetic knowledge industries because of the central role of tacit knowledge and face–to–face interaction, while in those sectors dominated by an analytical knowledge base with greater prominence of codified knowledge in the relationships means that learning processes will not be locally bound to the same extent. Nevertheless, studies have revealed that businesses within for example biotechnology tend to form clusters. However, recent Canadian studies show that ICT clusters reveal quite low amount of inter–firm collaboration in the form of key customer or supplier relationships. The

inter–firm dynamics seem to be characterised by quite fluid relationships between customers, suppliers and competitors.

Also, knowledge flows in synthetically oriented sectors like aerospace which increasingly involve the integration of complex subsystems draw upon global networks. On the other hand, a number of case studies seem to confirm that the local dynamics of social interaction between members of the cluster is crucial to the circulation of knowledge, or flow of knowledge, in the cluster, so that knowledge flowing through pipelines and local buzz is intersected or merged within a cluster framework (Gertler and Wolfe 2005).

As we have hitherto demonstrated accumulation of local or tacit knowledge is a basic prerequisite for interactive learning inside and among firms. It is widely held that such knowledge accumulation and learning is attached to local places and milieus, and to norms, values, cultures and social capital reproduced in such places. At this 'location' knowledge is mainly tacit and is accumulated through local informal networks. The knowledge is disseminated and shared mainly through personal connections (Cooke 1998, Isaksen 2000, Asheim and Isaksen 2000). A spatially bound combination of tacit and formal knowledge is taking place, this combination, however unfolds in a wider environment. It is also pointed out that knowledge is shared and combined in milieus and networks encompassing several local places and actors from different regional places and positions. The networks are still rather informal and personal (Wolfe and Gertler 2003: 1079). Dissemination and subsequent accumulation of synthetic knowledge, however, needs more formally institutionalised channels and arenas, and when these are activated, so called collective learning evolves, and more systemic relations can be seen within local production systems, in clusters, in industrial districts or innovative milieus (see Cooke 1998, Porter 1998, and Mouleart and Seika 2004 for overviews).

Still, the main actors are connected to businesses, and to business to business channels. The role of channels (and the concept itself) in dissemination of knowledge, also in regional networks, is studied in Amdam and Bjarnar 1998 and Bjarnar et al 2001. These studies are based on the thesis that flow of knowledge is a social phenomenon, and that channels are genuinely social channels where actors are 'negotiating' what is the meaning of conveyed messages (for example innovations). This converges nicely with the emphasis on *interactive* combination of tacit and formal knowledge through regional networks. Conversely, much economic literature see channels only as devises for transmission of information, which converges largely with the emphasis on linear dissemination of innovation as opposed to interactive models.

Within interactive frameworks innovation processes are frequent and they are territorially anchored (Asheim and Isaksen 2000). When such networks also interact more coincidentally with formal knowledge institutions inside the region, or across regional boarders, knowledge networks emerge that may encompass diverse flows of knowledge, be it through production systems, clusters, industrial districts or innovative milieus (Amdam and Bjarnar 1997, 1998).

This is quite important. As mentioned above, reading the mechanisms and consequences of globalisation processes or internationalisation on knowledge flow in clusters requires that the concept of institutional setting or framework is widened to look for production and reproduction of such structures and relations that stretches across different spaces and takes place within wider regional or national institutional frameworks. To cite Wolfe and Gertler (2003: 1079): "If, as we have argued above, institutions are the hidden glue that holds clusters together, the implicit question is whether the institutional structures relevant to cluster dynamics are exclusively those found at the local level". They conclude that clusters should be seen as nested within, and impacted by, other spatial scales of analysis, including regional and national innovation systems, as well as the global relationships evolving through the so called pipelines (see above). The implication is clear – there is a necessity do discuss over again how interaction between different settings or scales affect the production of and dissemination of tacit and formal knowledge.

Tacit knowledge is embodied in human and social capital. It consists of individual skills of more intuitive character achieved through learning by doing and learning by using. It is developed in interaction with colleagues and in apprenticeship–like relations. Equally importantly, tacit knowledge is anchored in specific routines, norms of behaviour, implicit and shared beliefs and modes of communication that stimulate flow of knowledge and interactive learning inside organisations, in firm networks and in local communities. 'Know how' can not easily be isolated from its individual, social and territorial contexts and the 'know how' character of tacit knowledge is embedded knowledge that is not easily codified and transferred through formal channels. Even though it can be transferred through the labour market as a channel, it is often quite firm specific and embedded in a multitude of inter–firm relations. It is therefore not readily disconnected from this social setting (cf. also Johnson, Lorenz and Lundvall 2002). This is why networking emerges, since firms need access to this stock of knowledge, and networking is the only way to merge such knowledge and create synergy and learning, since networks creates arenas in which different kinds of knowledge

can be intersected (Asheim and Isaksen 2000, they are referring also to Malmberg et al 1996 and Maskell et al 1998).

In fact, smaller firms or organisations often depend on accumulation of knowledge in external networks. Industrial districts, clusters or production systems often consist of smaller firms that have to solve complex production processes. They are dependent on the creation of broad holistic *synthetic* knowledge – which is merged tacit and formal knowledge – and which they cannot sufficiently accumulate on their own. Such knowledge is, consequently, accumulated in external knowledge networks. Even larger firms may depend heavily on this external knowledge stock in case they operate such synthetic knowledge, inside the organisation and through external interaction with this pool of knowledge. If so, they are spatially embedded hierarchies (Asheim and Herstad 2003, Lam 1998).

Some authors claim that tacit and synthetic knowledge is increasingly being codified. Codification makes tacit and locally embedded knowledge globally available and is turned into ubiquity knowledge. Consequently, local comparative advantage rooted in local tacit knowledge is steadily vanishing (Maskell et al 1998). Others, however, argue that if the transfer of codified knowledge takes place at un–precedent speed, the importance of tacit and non–codifiable knowledge increases. It is important for the innovative capacities of firms and networks, and is not readily accessible through copying. Comparative advantages, therefore, is even more connected to local knowledge than before. Furthermore, it is argued that an important part of codified knowledge, in the same vein as tacit knowledge, is the result of localised learning and is not geographical mobile. Knowledge in this sense is codified, tacit, and *contextually disembodied.* This means on the one hand that it is not embodied in technology and on the other hand that it is codified as a localised form of knowledge that is both dependent on and limited by contextual tacit knowledge. Hence, the dichotomy between formal and tacit knowledge is somewhat downplayed, and symbiotic synthetic relations between them is coming more to the forefront (see Asheim and Cooke 1998).

Codified knowledge is created through systematic research activities and is in principle universally available. Firms obtain such knowledge by recruiting educated workers and through direct contact and co–operation with knowledge institutions. In addition much knowledge is embodied in flow of physical capital like machinery, components and products. Firms also produce such knowledge in their own R&D laboratories. In reality there are usually substantial costs connected with identifying, assessing, assimilating and applying codified knowledge. It requires decisions and investments to make it valuable, and it is difficult to implement unless fused with less transitory knowledge embedded in local

environments in tacit forms. According to Lundvall and Borrás (1997: 39), “The region is increasingly the level at which innovation is produced through regional networks of innovators, local clusters and the cross–fertilising effects of research institutions”. The term ‘regional cluster’ is also used more frequently (Asheim and Isaksen 2000: 177). They are seen as geographically bounded concentrations of interdependent businesses with active channels of business transactions, dialogue and communication. It is stressed that without active channels even a critical mass of related firms is not a local production or social system and therefore does not operate as a cluster.

The creation of synthetic knowledge is not only promoted through business to business channels, but also through a number of knowledge networks – or a broad knowledge infrastructure – encompassing vocational schools, regional (technical colleges), regional research institutions, local and regional associations. Many firms rarely use R&D–institutions directly when innovating, hence it is not a clear cut regional innovation system. Two important traits are seen, however, that innovative activity increasingly is involving the use of R&D-based knowledge disseminated through these partly firm–external networks and also that several larger but local companies are establishing their own R&D–departments, many with global connections (Isaksen 1999).

Again, focusing on knowledge forms, global as well as local, it seems that space in terms of regions or clusters is gaining importance in a global world. Moreover, evidences can be traced that the increasing role of space in such terms is in particular connected to clusters where production is dependent on creation and reproduction of a synthetic knowledge base. In many ways, this underpins and strengthens the applicability of the social network model of micro regions and clusters, although it appears that we have to understand social networks and institutional structures as transcending such spatial formations of knowledge. Pipelines are increasingly important as an institutional structure that transcends space in this respect.

As will be illustrated below, however, the general data on the increasing presence of MNCs in clusters, on their localisation patterns in different types of clusters, and the reviewing of some recent literature concerning overall cluster models as well as essential knowledge forms in relation to such localisation, do not answer satisfactory how globalisation processes or internationalisation affects knowledge flows in clusters. In order to meet such questions, it seems paramount to conduct analysis at less aggregate levels, and to cast light on certain institutional dualities connected to the presence of MNCs that affect dissemination of knowledge. These findings clearly suggests that we not only have to focus on different cluster models, and also different types of clusters in form of their production and their knowledge

architecture (formal, tacit, synthetic knowledge bases), but also on forms of knowledge. Can we speak of global knowledge versus local sticky knowledge and amalgams between these forms that should be addressed in order to uncover globalisation of knowledge flows in clusters?

Table 2: Classification of local and global knowledge

	Local sticky knowledge	**Global ubiquitous knowledge**
Formal codified knowledge (know what, know why)	Scientifically knowledge which is locally disembodied as it is produced in co-operation between local firms and R&D-institutions, and since some tacit knowledge is required in order to handle and use the codified knowledge.	Scientific knowledge and information produced in R&D-institutions and universities that may be transferred through formal learning, recruiting, textbooks, an via purchase of machinery, components etc.
Informal experience based tacit knowledge (know how and know who)	Firm-specific knowledge and knowledge produced in networks of (often co-located) firms, produced and transferred through learning by doing, by using and by watching.	Knowledge which can be transferred through recruiting workers with specific experience, but the knowledge may be of less value and difficult to use outside its local context or outside specific firms and industries.

Source: Asheim and Isaksen 2000, fig. 8.1: 172.

Now then, how are global actors increasing presence in clusters expected in recent international literature to intervene with these localised or local–global learning processes?

Table 3: Propositions in current literature concerning clusters, globalisation and knowledge flow

- The importance of local contextual and tacit knowledge and the dissemination of such knowledge in regional knowledge networks are diminishing. Knowledge accumulation, accordingly, becomes increasingly independent of space.
- Strategic knowledge, tacit as well as codified, still is disembodied. It is neither contained exclusively in the organisational forms of firms, nor is it contained exclusively in technology, but still in clusters or networks. Accumulation of tacit as well as codified knowledge depends heavily on localised interactive learning. Knowledge accumulation is therefore not placeless but geographically "sticky" and competitive advantage is increasingly found in cluster dynamics of knowledge transfer.
- Globalisation leads to an increasing need for knowledge specialisation, which is a driving force toward shifting the regional balance of formal and tacit knowledge in favour of formal knowledge.
- As firms internationalise, intimate local relationships become less significant. Firms pursuing strategies to develop capabilities outside their homer region elect to reorient their level of intra- vs. inter–cluster interaction.
- We are witnessing a shift in emphasis within clusters from building and transferring tacit knowledge towards handling flows of codified information.
- Non-local and international links are more crucial for knowledge flows in clusters. Successful clusters are those that effectively build and manage a variety of channels for accessing relevant knowledge from global sources.
- Localised learning and knowledge flows are more important in synthetic knowledge industries because of the central role of tacit knowledge and face–to–face interaction
- Sectors dominated by an analytical knowledge base with greater prominence of codified knowledge in the relationships means that learning processes will not be locally bound to the same extent.

4. Global actors and knowledge flow in clusters – a general framework

Approaching this theme, it is in the first place necessary to address motives for and type of presence of MNCs in the actual cluster one seeks to explore. One of the most characteristic features of the new knowledge economy is, as mentioned, the growing presence and role of MNCs in clusters. A MNC is generally speaking an institution which owns or controls value activities in at least two countries, many of them controls such activities in a large number of countries (Dunning 2000: 195). Roughly one can discern the multi–domestic MNC structure from the globally and regionally integrated MNC.

The multi–domestic MNC tend to be drawn to clusters to set up wealth creating units that are treated as autonomous subsidiaries. They replicate the asset exploiting of the mother company and serve local or closely adjacent markets. There is little trade in finished products between the mother–companies and subsidiaries and between subsidiaries. Foreign affiliates of such corporations tend to locate in or near large conurbations, often near leading ports, but also in sub–national clusters of related activities. Many studies have shown that micro–regions are also increasingly attracting such MNCs (Dunning 2000: 196). In other words, the multi–domestic MNC has a high degree of local adaptation, while the reverse is the case of the more clear–cut global MNC.

The main feature of the integrated MNC, on the other hand, is a systemic and holistic approach to its global operations. Foreign subsidiaries are parts of a network of interrelated activities designed to promote the overall interests of the corporation. It is more inclined to connect to clusters in order to augment its resources and capabilities through efficiency seeking investments than the multi–domestic counterpart. The integrated MNC promotes three kinds of cross border specialisation. Firstly, each of the products supplied by the same corporation is produced in different regions or countries in order to take advantage of economies of scale and differentiated consumer markets. Secondly, vertical specialisation promotes value–added chains where different stages of production are undertaken in different locations. The main objective of this type of specialisation – predominantly occurring between developed and developing countries – is to take advantage of differences in factor costs and consumer tastes and to some extent gain scale economies.

The so called asset augmenting specialisation is designed to enhance its future wealth creating capabilities in a cost learning effective way. According to Dunning (2000: 197), the geography of this kind of labour is mainly confined to the advanced industrial countries and geared to either promoting the efficiency of the MNCs global R&D capabilities, or gaining

access to foreign created assets which will best protect or enhance its competitive advantage: "It is this kind of specialisation which is being increasingly fashioned by the imperatives of the knowledge based economy; and by the need of firms located in one country to complement their core competencies with those of firms located in another country". From the outset, it also seems fair to suggest that such MNCs attach to clusters not only as atomistic firms in agglomerations, but also as actors in cluster formations built on knowledge flow through social networks.

But why locate in micro–regions or clusters? In the first place horizontal and vertical specialisation may benefit from reduced transaction costs favoured by proximity in a cluster, so that it can exploit the benefits of so called un–traded interdependencies. And as, over time, the clusters have evolved their own nexus of innovating and learning capabilities they generate dynamic externalities to the participating firms. According to Dunning (2000: 198); "It is our contention that the dynamic externalities associated with these horizontal and vertical clusters are becoming more important as intellectual capital becomes more sophisticated, idiosyncratic, tacit, complex and context dependent". There is, however, a third type of industrial specialisation and clustering which has attracted increasing attention, namely the spectacular development of business, industrial and science parks, and specialised service sectors, which are all "testimony to the belief that the asset augmenting activities of firms benefit from being part of a knowledge–creating milieu – in which private firms, universities, technical colleges, and government research institutions are all involved." Thus, firms are attracted to "pockets of intellectual capital in a foreign country" (Dunning 2000: 199). Firms scan the globe for knowledge capital and tap into and exploit firm, country or cluster specific resources and learning capabilities, by acquisition or merger, coalitions, alliances or networking partners. MNCs and their affiliates are being increasingly drawn to networks of "sticky" places for their wealth creating activities. If so, they are increasingly also drawn to micro regions in the form of systems of social networks and institutions.

The knowledge economy has created a drive towards reducing costs connected to cutting edge technological development and the growing interdependencies of different technologies that lead the MNCs to locate both R&D and production in a geographical area that can accommodate concentrated nexuses of competitors, suppliers, customers and firms using common support services, still small enough to maximize the benefits of un–traded interdependencies. In this respect, says Dunning, "there is no real paradox of geographical space […] globalisation and localisation is the opposite sides of the same coin" (Dunning 2000: 200). Table 4 below summarises an overall pattern of connections between MNC

strategy and location and role in different types of clusters. In order to grasp the mechanisms trough which globalisation processes or internationalisation effects knowledge flow in clusters, one should seek to understand the motives and the modes of establishments in clusters, since we would expect such factors to influence their regional role.

Since the aim of the paper is to uncover and raise the more urgent questions connected to how globalisation processes or internationalisation, like when MNCs enter clusters, affect the flow of knowledge in clusters, we need to undertake a more systematic analysis of how different cluster models are supposed to treat creation and flow of knowledge when the larger "hierarchy" meets the local "milieu". In that respect, we have already suggested that the role of the MNC may differ in case they either connect to agglomerations or to social network based clusters. In agglomerations or industrial complexes they may act in similar vein as other companies – they mainly are atomistic and strategic units benefiting from general spill–over of knowledge. In social networked clusters the picture may be more blurred. Instead of being ad–hoc operating atomistic firms they will likely experience a tension between this kind of economy of scale that the cluster is offering and subsidiary autonomy and the need to engage in social structures and institutions to be able to reap the benefits of the knowledge accumulated in these networks.

5. Globalisation of knowledge flow and institutional dualities between systemic relations and spill-over mechanisms and between internalised and localised learning

De Martino et al (2006) have studied the impact of firm internationalisation on local cluster relationships. They note that several scholars have researched the influence and the role of MNCs in established industry clusters from an 'outside – in' perspective, focused on the efforts of such companies to capture the local expertise and innovating residing in knowledge–intensive clusters (like Enright 2000, Dunning 2000). They note that only limited research has been carried out to analyse the impact of firm internationalisation on cluster relationships from and 'inside – out' perspective, especially to determine whether internationalisation of locally established firms weakens the systemic relationships within the cluster.

De Martino et al study the Rochester photonic cluster in the US, and find that as locally established firms internationalise, they tend to reduce their degree of local collaboration and interaction. However, the balance between local vs. non–local cluster relationships is influenced by the manner in which firms elect to develop their organisational

capabilities. This is a key methodological approach in their study, as it is establishing a conceptual framework linking local embedded–ness, firm internationalisation and firm growth strategies.

Table 4: Type of clustering processes and the role of MNCs

Type of cluster	Main characteristics	Presence and role of MNCs
Hub and spoke	Nucleus of flagship firms (hub) generates a circle of satellite (or spoke) firms	Success of cluster rests on the capability of the flagship firm to leverage and develop a network of suppliers and customers which are able to gain external economies also from each other. Foreign MNCs can play that role
Concentration of enterprises engaged in similar economic activities	Each firm can draw from external economies and a common pool of natural resources and infrastructures	Foreign MNCs may be present to some extent, but the main cluster specific benefits emanate from a reduction of distance related transaction costs and from spill–over of knowledge
Innovative milieus	Institution building an learning economies and the sharing of collective knowledge	Foreign MNCs may have an important presence. In addition to asset exploiting activity they generally also aim at augmenting their existing competitive advantage through part-taking in institution building
Industrial district	Congregation of industries which generate a satellite of subcontractors in adjacent regions. Such clusters are strongly dependent on national (rather than regional) policies	Foreign MNCs may act as flagship firms, but cluster formation is more explicitly driven by national policies than in the classical hub and spoke cluster
Export processing zones in developing countries	Stimulating foreign MNC operations and setting up of export oriented labour intensive activities	MNCs presence is paramount to foster not only enclaves of businesses but also a continuous upgrading of indigenous resources. They engage mainly in resource seeking, market seeking or efficient seeking investments
Clusters with very sophisticated broad infrastructure	Clustering around science and technology parks that contribute to institutional infrastructure and an innovative milieu which generates flow of knowledge and refinement of social capital	Foreign MNCs play an important role. In addition to asset exploiting activity they generally also aim at augmenting their existing competitive advantage through part-taking in institution building and dissemination of knowledge

The table is based on Dunning 2000: 201-5. Note: this should probably not be seen as a general cluster typology, and should be read more as clusters as a set of possibilities for location as they appear from the viewpoint of MNC's strategies.

The authors distinguish between different categories of industrial structures within the cluster, and show convincingly that cooperative patterns may vary from the outset since the different sectors within the cluster also varies according to form of production: 1) between manufacturing sophisticated glasses or plastic devices directly for the, mostly local, end market, and 2) value added producers that possess both design, testing and manufacturing capabilities and can handle complex value added stages of production and solutions, and 3) subsystem and system producers that rely heavily on their engineering expertise to develop

light–based systems required in a number of different markets such as semiconductors, medical sensing and communication equipment. Firms within these different categories tend to have different growth strategies, and incorporate internationalisation as a part of their strategy also differently.

Corporate managers within the different categories are interviewed especially regarding the relations to local suppliers, end users, knowledge institutions (schools, academic institutions) patterns of firm level internationalisation, patterns of interaction with partners, and their initial and future growth strategies in light of market opportunities. The strategy is to use partly firm specific traits of growth and internationalisation to characterise changing milieu characteristics. In line with a more social interaction perspective on cluster relations they anchor the above mentioned framework in the milieu concept and say that "viewed systematically, the milieu is a complex network composed primarily of informal social relations that enhance local innovation through synergistic and collective learning processes" (De Martino et al 2006: 6. See also Camagni and Capello 1998, Cooke 2002, Camagni 2004). By incorporating firm growth strategies in their analysis, they seem though to succeed in forging a link between the social networks approaches and the business strategy approaches (Porter–inspired), between broader milieu effects, innovative dynamics and more general spill–over of knowledge and agglomeration effects. However, changing patterns of collective learning and interactive innovation can only be depicted against a broader background of social interaction. For example, they highlight, like other scholars, that you can find proximity without interaction (De Martino et al 2006: 8). This finding is, though, based on the investigation of formal linkages between institutions, not so much on studying informal structures as well.

The table below demonstrates clearly that as firms internationalise, they also loosen their systemic relations inside the cluster, and interaction takes on a more ad–hoc character. This does not in general mean that clusters are deteriorating or that being there becomes less important. All the companies in the study, but one, say that the readily available supply of trained engineers and technical workers is one of the top factors for staying in the cluster. Moreover interesting is that only those executives from firms with non–local facilities or from firms with parent companies based outside the region report that they attract non–local specialists into the region to fill internal positions. Nevertheless, the same companies say that the vast majority of such personnel are locally recruited.

On the other hand, companies that are units of larger companies tend to be more internationally oriented. Four of the companies in the study's population have been purchased

by out of town companies. Two of them share marketing facilities with their parent companies and the two others have established independent international market units. All in all, firms with outside operations are, as a group, less embedded within the regional cluster than those lacking external activities. They report less interaction in manufacturing, subcontracting, supplier relations and design (De Martino et al 2006:16). Firms acquired by outside MNCs are also less inclined to interact with the local community. A deeper insight into this pattern requires an evolutionary perspective on firm growth in clusters. It seems to be clear that there is a correlation between the degree of firms increasing organisational capabilities as they mature, spurred by inwards or outwards internationalisation, and lessened reliance on cluster relations (Table 5).

This picture is strengthened by comparing with other cluster analysis. For example, the above mentioned study of clusters in Denmark concludes that relations to suppliers inside clusters are weakened when local companies have grown to the extent that local supply becomes insufficient for further growth (Andersen et al 2006). On the other hand relations to end users are becoming tighter, however, this link is increasingly global and more than before concentrated on gaining market shares in specific international market segments. Local interaction has an only marginal effect on such companies' financial turn over. Especially relevant for the use of the pipeline concept in cluster studies, it is demonstrated that innovation processes are increasingly structured in form of strategic projects and business alliances that are both more exclusive and global and, subsequently, transcends the open membership in innovation in the clusters. Moreover, it is found that local arenas (meetings, conferences, work shops, local or regional exhibitions etc.) are loosing importance at the expense of large international gatherings. To fill in the picture, international managerial and organisational standards play a far more important role than hitherto: "Increasingly they seem to replace norms and codes that have hitherto been accumulated and internalised in the milieu. In consequence, the tacit local knowledge that has coordinated the cluster economy is downplayed, so that flow of tacit knowledge is now more connected to fields of practices constituted within international or global value chains" (the authors' translation) (Andersen et al 2006: 50).

In general, firms in the studied Danish clusters orient their collaboration towards tighter contact with end users. And since these end users are increasingly foreign, in the international sphere, this affects the firms learning processes so that they are less dependent on local interaction. It has been suggested, that the clusters' social capital is diminishing (Andersen et al 2006: 54). Changing cooperative focus has an impact on traditional local

agglomeration advantages. On the one hand, firm's international trade or development partners or connections are thinning out aggregated demand inside the clusters. On the other hand, as a consequence, the clusters thus strive to maintain a critical level of coordination of specialised production and services necessary to function as a cluster (Andersen et al 2006: 52).

Table 5: Systemic and ad –hoc cooperation in clusters related to category and extent of non-local operations (in Rochester)

Category	End users	Milieu	Non-local linkages and local collaboration
Precision optics	Mainly order takers. Minor collaboration. Few local customers	Report strong informal relationships with local peers and competitors. Systemic nature.	Firms with no external operations report strong local collaboration. The only firm with external operations reports low local collaboration
Subsystem Producers	Important collaborators	Informal relationships are important mostly for firms without foreign operations	Firms reporting no external operations also report high degree of manufacturing collaboration. Firms with external operations report low degree of local collaboration
System producers	Very important collaborators	Milieu is important, but based on presence to enjoy spill–over mechanisms. Less systemic and informal interaction. More ad hoc nature. Internal capabilities are more important than accumulation of knowledge through local networking	Firms without external operations report desire to collaborate locally in order to find partners, consultants and new markets. Firms with some external activity report that they obtain most of these contacts through the cluster. Firms with external operations place a lower emphasis on local design and engineering collaboration. When they cooperate locally it is also ad–hoc to fill specific needs

Based on the authors' summary of De Martino et al 2006: 12–14

Like in the Rochester case, when elements of local value chains become part of global corporations' value chain, this further even more lessened local reliance. The form of acquisition and degree of subsidiary autonomy, however, matters. Firms that are not integrated into the operations of the MNC report a higher degree of local collaboration (De Martino et al 2006).

The findings in De Martino et al (2006) can be related to a wider outlook on MNCs, globalization processes, cluster dynamics and flow of knowledge. While the study reveals interesting processes and changing structures, we still know less about the qualitative aspects of the changes, their content and context, and to what extent changes in local interaction changes flow of knowledge as well as the competence base of the cluster and its balance between local and external knowledge. The balance between formal and local or tacit knowledge is not discussed in the article. However, the study generates an interesting

possibility for an ideal type dichotomisation concerning the role of MNCs, incoming as well as inside–out companies: namely their role in systemic relations in the cluster and their presence there mostly for tapping into externalised spill–over mechanisms unfolding in the cluster.

Table 6: Globalization and MNCs in systemic or/and ad hoc relations in knowledge flow in clusters

MNCs in systemic relations	MNCs in ad-hoc relations
• Build institutions for interactive learning and knowledge sharing • Foster collective learning through institution-building • Long term commitment to non-market relations, networks and institutions • Anchored in epistemic communities, culture and trust	• Proximity creates myriads of contact points where knowledge spill over and facilitate monitoring • Collective learning through spill-over • More ad-hoc relations to institution-building • Trust and culture developed through formal and repeated business transactions and supplier – buyer – relations • Arenas more likely to shift over time and become more fluid

Moreover, it is important to ask whether a shift from systemic to more ad–hoc relations would likely be changing learning processes in the cluster in terms of increasing diverging processes. While many of these aspects are not explored by De Martino et al (2006), such questions are more thoroughly addressed in a recent study of MNCs in a Norwegian cluster. All in all, though, the findings in the Norwegian study are largely consistent with the picture drawn of the photonics cluster in Rochester.

Asheim and Herstad (2003) studies MNCs role in the Jæren area in South–Western Norway, where, among other things, high tech painting robots for the car industry are produced. In general the cluster is characterised by new and mature firms that are quite dependent on the knowledge accumulated in the clusters' networks to carry out process innovations through supplier and design collaboration. In the late 1980s, the global corporation ABB bought the local firm Trallfa Robot, at a time when this local company had 50 percent of the European market. A central motive for the buy in was to tap into the clusters pool of competence. It was seen as a unique combination of tacit knowledge and social skills, which again was combined with localised codified knowledge. Hence, the knowledge base was disembodied, or geographically 'sticky'. The knowledge was largely accumulated in cluster networks. It was, moreover, 'synthetic'. The end product was put together by mechanical knowledge, chemical knowledge, physics knowledge, technological knowledge

and logistics knowledge, through a complicated cooperative process that required high tacit competence to make the production process work.

The largest incoming MNC, ABB, in the cluster is characterised as an embedded hierarchy. It moved production from Germany to Jæren, and gained substantial market shares in the US and in Asia. Its operations still depend substantially on local intimacy and interaction in order to reap the benefits of the synthetic knowledge pool. On the other hand we see the same patterns as described by De Martino et al (2006). The increasing need for more specialised knowledge that can be acquired through international corporate networks drives internalisation of knowledge production and knowledge flow. The ability to utilize external international knowledge and disseminate it through internal corporate networks and hierarchy may at the same time reduce its ability or willingness to communicate this knowledge in the cluster, but we have no definite conclusions in this respect.

The situation is probably best conceptualised as "institutional duality", a growingly well established concept within business strategy literature on learning in MNCs. Subsidiaries are drawn between local embedded–ness and localised learning and the MNC headquarters' need to standardise, formalise and internalise knowledge flow for reasons of greater efficiency (Wang and Ouyang 2006). Within the same framework, it is increasingly, however, recognized that actors within the MNC may have multiple visions of the content and context of the knowledge transfer (confer for example Kostova and Roth 2002). Lervik (2007, forthcoming)), nevertheless, shows convincingly that international management and strategy research has been short of perspectives on how knowledge is created and shaped by specific institutional and cultural contexts both in home and host settings and is thus only imperfectly transferable. This highlights the need to study MNCs in a cluster context and within the social interaction framework, which seems to offer a richer understanding of knowledge creation and diffusion than pure agglomeration or industrial complex approaches.

General background factors may accelerate this institutional duality creation. As we have already mentioned, it is important to relate clusters to their wider institutional surroundings, be it regional, national or international. In the process of growth, for instance, a larger corporation may be knitted to its original surrounding financial structure and labour market systems. These can be conflicting with the respective relations in clusters. The combination of higher education and vocational education in the original environments may influence its learning strategies and processes, as it is argued that a poorly developed vocational education system in the home country will hamper the ability to accumulate tacit knowledge within the firm and between firms. The same conditions in the foreign country

may also influence this form of knowledge accumulation. Lazonick and O'Sullivan (1998) argue for example that in liberal market economies the balance between formal elite education and vocational education is largely in favour of formal higher education. These labour markets are, besides, highly polarized measured by forms of knowledge they generate. This is reflected in the firms' ability to accumulate both formal and tacit knowledge, causing hierarchical and functional segmentation and a poor context for broad interactive learning. Conversely, in more coordinated market economies that are much less elite based, and with a better balance between formal and vocational training, cooperative institutional environments will create more advanced context conditions for the firm to combine internal accumulation of formal and tacit knowledge and engage in external interactive learning.

More coordinated market economies may offer two, partly interrelated, situations. The MNC may operate within an occupational community labour market, where cooperative institutional frameworks and a good balance between formal and vocational education promote knowledge dissemination through external mobility and transfer of combined knowledge contained within networks and other social structures. It may also adopt a more organisational community model, which means that interactive learning and diffusion of knowledge takes place through internal hierarchical or functional mobility within a formal organisation, for example through long–term employee commitments. In conclusion: "Within these two models, non–transparent tacit competencies are easily identified, and, thus, tacit knowledge is easily diffused inside and between organisations" (Asheim and Herstad 2003: 215).

In both cases, however, the MNC may operate as a strategically integrated corporation in terms of learning and diffusion of knowledge, and it will take form of an embedded hierarchy. In both cases the learning process will be *localised*, with more or less shifting balance between internal and external accumulation of knowledge. In Malmberg and Maskell (2006: 1) localised learning is defined as "[…] how local conditions and spatial proximity between actors enable the formation of distinctive cognitive reportoirs and influence the generation and selection of skills, processes and products within a field of knowledge or activity". This may, judging from the above perspectives, mean localised learning with shifting emphasis on internal and external interactive processes.

The term 'cognitive reportoir' is somewhat vague, however, and we will further explore this dimension by examining what kinds of knowledge and their attached patterns of learning this could encompass. Once we adopt this two–aspect approach, i.e. the embedded hierarchy as both internal and external accumulation of tacit and formal knowledge, the

corporative level must be addressed more systematically. Since the embedded hierarchy obviously synthesises different kinds of knowledge generated in different cultural and institutional contexts, we would also need broader cultural analysis to see to what extent cultural synergies are created inside the corporation that converge with or diverge from the regional. What makes this approach essential, is, that as growing MNCs increasingly become structures of their own, the 'cognitive reportoire' created inside the corporation may in principle be broader and more comprehensive than the repertoire they can generate through external interactive learning in their host or foreign regional networks. Above we have doubted this argument, however, based on Bathelt et al 2004, as a common trait for all models of clustering seems to be that the MNC gains access to accumulated knowledge that could hardly be matched by any single organisation regardless of size.

6. The embedded hierarchy in cluster context – organisational form and cluster knowledge base

Current literature on possible diverging regional learning processes has adopted a framework consisting of four basic 'knowledge architectures' with their respective organisational forms and how they may be expected to create interactive learning internally and externally to firms or organisations. Two of these basic categories have already been explored above, namely tacit and formal knowledge. Secondly, a distinction is made between collective and individual knowledge, determined by who is the 'container' of the knowledge, the 'agent' or 'knowing entity'.

Knowledge within the firm can reside at the level of the individual, says Lam (1998), or be shared among members of the organisation. Individual knowledge is that part of the organisations knowledge that resides in the brains and bodily skills of the individual, whereas collective knowledge refers to ways in which knowledge is distributed among members in an organisation. It is the accumulated knowledge of the organisation stored in rules, procedures, routines and shared norms which guide problem–solving activities and patterns of interaction among its members. Collective knowledge exists between rather than within individuals.

Embrained knowledge is dependent on the individuals' conceptual skills and cognitive abilities. It is formal, abstract or theoretical knowledge. Embodied knowledge, on the other hand, is action oriented, it is the practical individual type of knowledge with a strong automatic and voluntaristic component, as its generation does not need to be fitted into or

processed through a conscious decision–making schema. It is context specific, a kind of 'particular knowledge'. Its generation cannot be separated from its application.

Table 7: Cognitive levels and types of knowledge

		Ontological dimension	
		Individual	Collective
Epistemological dimension	Explicit	Embrained knowledge	Encoded knowledge
	Tacit	Embodied knowledge	Embedded knowledge

Source: Lam 1998: 491

Encoded knowledge is often referred to as information. It is stored in blueprints, recipes, written rules and procedures. It is abstracted individuals knowledge that fosters centralisation and control in organisations – scientific management for example. Encoded knowledge is, thus, the collective form of knowledge expressed through "the hierarchy". Embedded knowledge is, on the other hand, the collective form of tacit knowledge residing in organisational routines and shared norms, which makes effective communication possible. It takes character of socially constructed knowledge based on interactive learning and is relation-specific, contextual, dispersed, organic and dynamic. It can operate in the absence of written rules. Embedded knowledge is, thus, the collective form of knowledge expressed through "the milieu".

Organisations, as well as milieus, can of course combine these collective forms of knowledge. Organisations characterised by an explicit knowledge base tends to have formal structures of control and coordination and highly standardised tasks and work rules. By contrast, organisations with a higher degree of tacit knowledge base will exhibit a decentralised structure and use informal coordination mechanisms. Subsequently, hierarchical MNC organisations may internally have certain diffusion structures, competence bases and corporate cultures that make the interaction difficult with the diffusion in clusters dominated by more operative adhocracies that are relying more heavily on knowledge accumulation in external networks. It should be fair to argue that MNCs are more constantly exposed to a form of institutional duality between being in clusters in terms of systemic vs. more ad–hoc relations (Table 6).

Moreover important is that the accumulation of the two collective forms of knowledge, encoded and embedded, in a cluster perspective must rest largely on norms, cultures and values of informal and unwritten character that altogether constitutes the 'routines' that store and diffuse knowledge in clusters. It follows also, that if globalisation

means more emphasis on flow of formal knowledge and information in cluster dynamics, the balance between actors in the cluster will shift towards storing knowledge in formal structures and routines, hence it will probably render the larger MNCs prominence at the expense of smaller operative adhocracies.

The question should be raised, therefore, if globalisation will be expected to favour some dissemination carriers, channels and mechanisms at the expense of others, and if this will likely change the flow of knowledge in clusters. In order to receive and implement global knowledge, actors, organisations and firms may increasingly have to build more complex organisational models. The transfer of knowledge may require special intermediaries and specialised role functions, like consultants, to both convey general knowledge in the fields of business economics and business administration as well as interacting closely with upper echelon regional managers within operative fields. Hence, clusters may have to receive and disseminate a substantial structural capital, incorporating established trust and relationships and a set of alliances that ease the flow of knowledge, but which is carried through pipeline connections and via other carriers (Alvaro 2004, Amdam, Kvålshaugen and Larsen 2003, Kipping and Amorim 2003).

It is quite a puzzle why possibly changing structural characteristics of the clusters knowledge architecture has not been questioned relative to changing roles of transfer agents, intermediaries, channels or mechanisms. Moreover, too little emphasis has been put on principle–agency relations and the emergence of asymmetrical knowledge flow in organisations or in clusters (Andriusyte and Ragnarsson 2006). This is even more apparent, as it has now been observed that too little emphasis has been placed on discerning dissemination of innovations from dissemination of knowledge in general, since adopting an innovation is risky, and businesses even within a cluster may well reject an innovation (See Andretsch and Lehmann 2006). Hence, there are at least two different theoretical problems occurring in light of globalisation – how clusters can disseminate complex organisational or managerial models of external origin and what capacity clusters have to disseminate innovations through local–global knowledge channels. Naturally, this set of questions is coupled to the apparently changing balance between formal and local knowledge, between local channels and non–local linkages, between analytical and synthetic knowledge bases, between individual and collective knowledge, and between knowledge dissemination inside MNCs and diffusion within a wider cluster context.

These questions are connected to some other important aspects very recently discussed by Christophersen and Clark (2007), namely power relations in firm networks and global

networks. It appears that a MNC or a transnational corporation (TNC) can be embedded in clusters in such a manner that systemic relations are altered in favour of internalising knowledge and innovation capacity inside the TNC. They analyse power relative to regionalised SMEs, and conclude that TNCs are able to use their power to manage access to, and the orientation of, key production resources. TNCs use political power to influence regulatory policy, thereby affecting which innovations are commercialised and how knowledge is diffused. TNCs also drive the innovation agenda within publicly supported research centres and centres of expertise or excellence. Finally, they say, "TNCs dominate the regional labour market, using management resources to organize skill development programmes around their specific needs, and competing with SMEs for the most valued segment of the skilled workforce – experienced technically trained workers who combine technical and managerial skills. Since the TNC agenda diverges from and competes with that of innovative small firms it can limit or even squash SME's ability to reach their innovative potential" (Christophersen and Clark 2007: 1224). Some studies have revealed a direct competition over skilled workforce between global and local firms within clusters, and MNCs have the power to control the wage rate so that they attract the best personnel (Referred to in Christensen and Clark 2007 is Florida 2002, Pendall et al 2004).

Christoperhsen and Clark (2007: 1225) confirm the impression that much of the pipelines and policy–oriented literature see global firms as hub firms that connect local networks to global ones, enabling cluster based firms to expand and specialise. Several authors have challenged this convergence picture by suggesting a network paradigm in which relations within innovation based regional economics are infused by power relations (see also Kristensen and Zeitlin 2005). According to Christensen and Clark (2007: 1226), "What is missing from contemporary regional theory is an account of how the agendas of TNCs and SMEs can result in competing rather than cooperation and how TNCs have the upper hand in shaping the innovative potential of many regional innovation systems". TNCs may be removing resources from the region via rationalization and restructuring rather than inducing regional growth (Dawley 2007, Benneworth 2006). Market power combined with large in–house administrative and competence resources may lead these firms to dominate the local institutional framework and foster information asymmetries (Christophersen and Clark 2007: 1227, Boschma and Lambooy 2002). Due to international competition and the pressure to reduce risks and costs, they also have to focus on innovations that they can control and render new products with large potential growth in the short term (West and DeCastro 2001).

Connected to forms of knowledge, it should be plausible to suggest that if such power structures can be confirmed, it would shift the regional balance between flow of tacit knowledge through cluster networks and formal knowledge through pipelines in favour of the last. Moreover, if it is the case that MNCs or TNCs exercise control over innovation processes inside the cluster in favour of innovations that can be more readily diffused within the corporations, the transfer process itself would likely be affecting localised learning. We should therefore also take a brief look at some problems connected to standardisation and transferability of knowledge.

6. Transfer processes in buzz and pipelines

As mentioned above, one essential channel for knowledge flow is depicted as local buzz. *Local buzz* arises from physical co–presence. It incorporates both the broad general conditions that exist when it is possible to glean knowledge from intentional face–to–face contact as well as the more diffuse forms of knowledge acquisition that arises from chance or accidental meetings and the mere fact of being in the same location. Buzz is the mechanism that facilitates the circulation of knowledge inside the cluster and thus supports the functioning of networking. A myriad of contact points makes it almost impossible for firms in a cluster to avoid acquiring information. *Pipelines* refer to channels of communication used in distant interaction between firms in clusters and knowledge–producing centres located at a distance. The effectiveness of these pipelines depends on the strength of pre–established social relationships and the quality of trust that exists between the firms in the different nodes involved. No doubt, recent literature leaves the impression that pipelines are becoming more important in cluster dynamics. However, what is actually taking place inside these pipelines in a qualitative sense and in transforming concepts and innovations is perhaps not sufficiently theorised. In this respect, a focus on diffusion literature may render new insights into the globalisation of knowledge in clusters.

I seems appropriate seems fair to use the buzz and pipeline concepts as a point of departure and investigate theoretically how they are operative and further globalisation in two respects – the diffusion of innovations and the diffusion of managerial and organisational knowledge. According to Rogers (1995:7), diffusion can be defined as “the process by which an innovation is communicated through certain channels over time among members of a social system. It is a special kind of communication, in that the messages are concerned with new ideas”. Channels are connecting actors and institutions in such a way that messages are

communicated between them. Mass media channels for example, are useful in creating knowledge of innovations, “whereas interpersonal channels are more effective in forming and changing attitudes towards the new idea, and thus influencing the decision to adopt or reject a new idea”.

If pipelines are of growing importance in clusters, so must carriers of knowledge and their channels be essential focuses. Comprehensive studies have established a typology of the different intermediaries, or ‘linkers’, and their interplay in the diffusion process (see Havelock 1969, cf. also Fridenson 1994, Bjarnar and Kipping 1998, Bjarnar and Kipping 2002, Amdam and Bjarnar 1998). Among these linking roles, at least three should be paid more attention to in cluster approaches. First, the so called conveyors should be studied. Their role consists of the transfer of knowledge from its producers, such as researchers and experts, to its users. Such functions can be carried out, for example, by agents, trainers, demonstrators, system engineers, scientific experts and teachers. Consultants, on the other hand, are seen to assist users in the identification of problems, in establishing a link with the appropriate resources for their solution and in the implementation of this solution. Thus they act primarily as ‘change agents’, which includes the roles of facilitators, objective observers and process analysts. An especially prominent position in the diffusion process can however be attributed to the leaders who are executives either of companies, whether in the private or public sector, or of trade associations. Unlike conveyors or consultants, they are ‘insiders’ of the receiving system and as such not only have a powerful influence on their own organisation, but can also provide an important example for others.

These ‘linkers’ have to be seen as part of social networks, which influence and determine their relationships to both producers/senders and users/receivers of knowledge. If the term local buzz has explanatory power, it should at least be able to account for and identify forms of managerial networks. It is therefore crucial to limit the analysis of the transfer process not only to anonymous institutions and structures, but to also study informal personal relationships and contacts, the role of reference groups as well as the social strategies pursued by different actors at different stages in the dissemination and adoption process. For example, the extent of the social network of a manager rather than his or her formal position might be a key factor for the introduction of new management models in a company. Similarly, a small, but socially and politically influential group can pave the way for a widespread diffusion of technological or organisational know–how in a cluster and decide its channels and networks, or they can act as gate–keepers to prevent local dissemination at the expense of in–house control of innovative processes, or they have the position to sense new

prosperous ideas emanating from local buzz and allocate resources to disseminate them inside the corporation. At the same time, it should not be forgotten, that those not involved in the transfer process it self, but concerned with its outcome, like the middle managers and workers, may play an important proactive or reactive role for the adoption of new knowledge and innovations.

'Institutions' can be defined as a set of practices that are partly dependent on structural and material conditions, partly on norms, values, cultures and mental constructs or cognitive processes; in other words (a) as patterns of human interaction and practices and (b) as symbolic systems, cognitive constructions, norms and rules (written or not) used by actors to categorise and give meaning to human action. "Institutionalists" hold different opinions on a wide range of theoretical problems, however, they have in common that they see actors as strongly influenced by the social–historical context they operate within, and take action based on ideas and norms that are deeply rooted in this context (North 1990, Powell and DiMaggio 1991, Whitley 2002). Within the innovation systems tradition the term "institution" is used somewhat vaguely. An innovation system can be understood as "a network of agents interacting in a specific economic/industrial area under a particular institutional infrastructure or set of infrastructures and involved in the generation, diffusion and utilization of technology" (Edquist 2000).

The role of actors is important, when it comes to the barriers that might slow down, obstruct or prevent the transfer of knowledge between organisations in a cluster due to the above depicted institutional dualities. These barriers can result from the personal or social implications of the required changes on individuals and from interpersonal problems between those involved in the transfer process. However excellent or objectively superior a new idea might be, it will be difficult to introduce if it challenges the status of an established business leader for example. Naturally, inter–systems barriers found in companies or organisations may have similar effects on the successful dissemination of knowledge. The individual actors and organisations involved in this process actually play an important role, not only as channels for the transfer, but also for its outcome, because the content of what was intended to be transferred was based to a large extent on their perception. When it comes to the role of institutions, these can act as channels themselves or, more importantly, facilitate the establishment of direct contacts between the different actors involved in the transfer process.

Studying the role of pipelines must incorporate the examination of managerial networks in knowledge diffusion, and the relations between pipeline–defined managerial networks and local buzz–defined networks. Few, if any, such in–depth actor/networks

analyses have been carried out so far within a cluster framework, at least frameworks anchored in economic geography. Furthermore, what figures even less in cluster studies of knowledge flows is the focus on the transfer process, of implementation of knowledge, or translation and transformation within clusters.

In an article on the transfer of management innovations from Japan, Paul Lillrank (1995) has proposed a model where transfer problems are related to the abstraction level of the innovation and whether the transfer process is demand driven or supply driven. Transfer of organisational innovations and learning from best practices is a complicated and slow process, more so than transfer of capital and technology. The term 'transfer' is defined by Lillrank to include both the study of successful practices and the active learning that goes with implementation. There is always a "distance" in such transfer, not only geographical, but also mental due to differences in culture, society and history, as well as strategic paradigms. The larger the distance, the more is lost of the original message. To reduce losses, new ideas and practices get switched up to various levels of abstraction and packaged for the transfer process. Such packages may include concepts, models, tools, propositions and illustrative examples. At the receiving end, an application process starts. By interpretation and reapplication over several learning cycles the receiver switches down the abstraction to suit local conditions. Thus the foreign impact becomes a part of the local learning process. This *transfer* process must be distinguished from merely *copying* of low-level abstractions, or tools etc. with rather clear–cut applications. The level of abstraction will be affected by the complexity of the system or idea to be transferred, and not only the complexity of the idea itself, but to number of types and interfaces as well.

Another problem is the often tacit knowledge embedded in management models, a component which tends to grow larger with the human content of the innovations. Via a combination of levels of abstraction with the approaches of the actors (supply driven or demand driven), Lillrank creates a model of transfer channels: (1) the low level abstraction supply–driven channel contains descriptions of new practices without deeper reflections or implications. This characterised for example the first attempts to transfer the Japanese Quality Control Circle (QCC) during the 1960s; (2) the low level abstraction but demand driven channel is activated when potential users discover the value of new practices or principles, but try to apply them very quickly; (3) the high abstraction supply driven channel is most typically used by scholars. According to Lillrank, it rarely attracts the interest of demand driven actors, unless the low abstraction channel works. (4) High abstraction demand driven channels come into use when the essence of the original is crystallised into general principles

with various practical applications. “When the Japanese practice of QC circles was crystallised into the concepts of Continuous improvement (CI), American and European applications began to emerge.” The introduction of the QCC was not successful in Western countries. Lillrank sees the failure of the Western QCC as a result of “pushing a complex organisational innovation through a simple, low abstraction transfer channel into a world dominated by very different management paradigms and principles” (Lillrank 1995: 982).

It could be argued that this kind of models is not especially useful in cluster analysis. Due to institutional and cultural proximity, new ideas may travel faster and easier than between countries. In case new ideas or innovations are generated ‘inside’ the cluster, the businesses also are already provided with the cognitive framework and the organisational capabilities needed for implementation. Transfer as well as transformation and implementation of ideas or innovations would be easier. Nevertheless, since flow of knowledge in clusters obviously is changing due to internationalisation and globalisation processes, the changing roles of actors, channels, transfer mechanisms and transformation should be drawn attention to. And if it can be argued that global–local linkages in knowledge transfer and application is of growing importance in clusters, and that flow of formal knowledge through larger bureaucratic organisations play a greater role, the questions raised in the model become essential. In other words, how does the pipeline and buzz concepts account for the complex interaction between abstraction levels of knowledge and related transfer channels? And moreover, what kinds of transformation processes are attached to these channels?

Two aspects or perspectives would be useful in order to capture the role of pipelines in clusters: a social interaction perspective and a problem solving perspective. The root of the social interaction perspective is anthropological studies of the diffusion of cultural traits. In this perspective, it is assumed an existence of an innovation as a precondition for any analysis of the diffusion process. The value of the innovation or the technical and scientific knowledge that might have gone into its original development is of little interest and don’t make much difference. The approach to studying dissemination in this perspective is to choose innovations that appear in very concrete form (drug, fertilizer, tool, machinery etc.) and the effort to measure its flow through a social system. In other words the interest is on patterns of flow and their effect on social structure and social relations. Some of the features highlighted in this kind of research have been the focus on social relations network, the user’s position in that network, informal personal relationships and contacts, the importance of reference group

identifications and the differential significance of different types of influence strategies at different stages in the adoption process (Havelock et al 1969).

Dissemination, diffusion or transfer of knowledge will always meet with complex and intricate sets of human substructures and processes. Innovations and new ideas, however brilliant, will not diffuse by themselves. It is also difficult to accept that dissemination and utilisation of knowledge really can follow a planned sequential step–by–step procedure, as illustrated above, or just spill–over inside a cluster. The focus on social networks is, accordingly, necessary. One basic discovery made within the social interaction perspective was the fact that initial acceptance by a small minority of key influential actors was the major force in diffusion to the community as a whole. Subsequently, dissemination is dependent on persons in social networks as well, not only on structures and institutions.

Dissemination is also about adoption. Within the social interaction perspective a phase model of adoption was established. Adoption of new ideas or innovations proceeds through awareness, interest, evaluation, trial and adoption and different types of influence strategy will be most effective in different phases. The social interaction approach came under strong critique (Havelock 1969). It did not pay attention to invention, research, and development of innovations. Translation, transformation and adaptations of innovations constantly going on as innovations diffuse through systems was understudied, as also the process of mal–adoption and rejection. Most importantly, however, the social interaction approach did not consider problems connected to knowledge flow within organisations, but mostly between organisations. Nevertheless, the obvious advantage of the social interaction perspective in light of globalisation processes is the learning that diffusion of innovations or managerial knowledge depends on social formations and networks, so that we can largely confirm the relevance of the local buzz concept – not only as a channel operative ‘inside’ clusters, but also as a force that may resist or adopt new ideas, whether produced internally through cluster dynamics or externally or globally.

In the problem solver perspective, knowledge utilisation is a part of a problem solving process inside the user, which begins with a need and ends with a satisfaction of that need. This is more the business literature approach. A stage–cycle–process theory is proposed; including six different stages. These are 1) needs sensing and articulation, 2) formulation of the need as a problem to be solved, 3) identification and search for the necessary resources to solve the problem, 4) retrieval of potentially feasible solutions and solution–pertinent ideas, 5) translation of this retrieved knowledge into specific solutions or solution prototypes and 6) behavioural try–out or application of the solution to need.

If the solution does not work satisfactory, the process will start all over again until the problem is solved on lasting basis. The main lessons to be picked up from this approach is that the users world is the place from which utilisation should be considered, that knowledge utilisation must incorporate a diagnostic phase, that the role of the outsider primarily is to act as catalyst, collaborator or consultant on how to reach solutions, that internal knowledge retrieval and marshalling of internal resources is equally important to external retrieval and that self–initiations by users creates the best motivational climate for changes (Havelock 1969: chapter 11: 13).

As adaptation of knowledge must be an essential part of knowledge dissemination, we may learn from the problem solver perspective that dissemination of knowledge is not likely to be successfully achieved unless the users are able to mobilize internal resources that are able to adapt external knowledge to inside needs. Dissemination of knowledge may be a question of power and conflict as well. This question is almost absent in all the different perspectives outlined so far, possibly with an exception of the social interaction approach. Even in cluster studies we need detailed studies of intermediary systems and how they operate in dissemination of ideas from 'producers' and/or 'senders', which are rarely identical, to 'receivers'. This detailed knowledge seems crucial in exploring how ideas work and to assess the outcome of transfer processes.

In essence, it may well be that the pipeline channels are anchored in specific problem–solving needs and processes connected to specialisation of knowledge, access to external knowledge bases in market knowledge or technological knowledge, or access to operational and managerial superior models or techniques. Again, this observation further stresses the need to look closer at knowledge transfer processes and reverse knowledge transfer within MNCs, and to which degree they are coupled to wider contexts in the home country or host country.

7. I**mplications for further studies of globalisation and knowledge flow in regional clusters**

Knowledge and flow of knowledge has over the last decades become perhaps the most central feature of modern global capitalism. As the core competencies of firms become more knowledge–intensive and mobile across space, the more the choice of location in the production, organisation and use of those assets is becoming a critical competitive advantage. Knowledge is different from other forms of capital. It is a heterogeneous commodity and can

be put to multiple uses as different kinds of knowledge needs to be combined with several other kinds to make a product, a good or a service. The intellectual capital needed to achieve that is rarely a property of one firm, and for a firm to increase its knowledge it will often have to access external knowledge by the way of some forms of collaborative agreement. In the new knowledge economy, knowledge may be expensive, risky to apply and quickly obsolete. These risks may be reduced when you get partners or decide to operate in special environments in order to access knowledge. The growth of the knowledge economy has led to en explosion of inter–firm alliances. And no doubt MNCs play a central role in globalisation of knowledge flow as well as in clustering of economic activity.

Studying globalisation in clusters in particular requires a much more persistent focus on knowledge creation and knowledge flow than has hitherto been the case. Spatiality in general and in the form of clusters or micro regions in particular is first and foremost attached to creation and dissemination of knowledge through social networks. We have shown that at the same time as global actors are present in clusters to a new extent, and add new sources of knowledge to the clusters, their presence may be challenging the established flow of knowledge and the institutional structures that facilitate this flow, because they may operate on more ad–hoc basis to ripe the benefits of knowledge spill–over than they engage in regional building of institutions. Regional or cluster arenas may emerge as more fluid and shifting. New managerial networks may also evolve with greater influence and power over the diffusion of knowledge.

We arrived at this hypothesis by examining two partly contrasting approaches which are cast light on in this emerging research. On the one hand it is questioned whether, in light of these global movements, the importance of local contextual and tacit knowledge and the dissemination of such knowledge through regional knowledge networks is diminishing. Knowledge accumulation, accordingly, becomes increasingly independent of space. Businesses may place more emphasis on seeking global formal knowledge than before, which supposedly might lead to the prominence of non–local linkages and fragmentation and deterioration of hitherto viable cluster economies in cases they are based on knowledge sharing through local social networks and institutions. On the other hand, in line with mechanisms briefly sketched above, accumulation of tacit as well as codified knowledge depends much on localised interactive learning. Knowledge accumulation is therefore not placeless – it is both disembodied and geographically “sticky”. Nevertheless, recent research indicates that as firms internationalise, intimate local relationships become less significant. The interpretation and implications of this observation is, however, by no means clear, and we

have hopefully demonstrated here that this question demands new case studies, however, case studies conducted within an overall framework that they can form the basis for mapping patterns comparatively.

We have argued that social interaction and social networks perspectives on clusters form a more suitable departure for such studies than allegedly pure agglomeration or industrial complex models and connected business strategy approaches, but that social network theory to a far more energetic extent than before need to incorporate institutional dualities as well as power relations and conflicting interests. It should by no means be denied, however, that flow of knowledge, in form of spill–over or transfer, is the core element in spatial analysis within neo–classical economics (agglomeration theories and industrial complex models) as well as in territorial innovation models developed within business strategy. Again to paraphrase Dunning (2000: 198); “It is our contention that the dynamic externalities associated with these horizontal and vertical clusters are becoming more important as intellectual capital becomes more sophisticated, idiosyncratic, tacit, complex and context dependent”. Across different territorial innovation models it is, nevertheless, proposed that the major advantage of geographical and social proximity is increased flow of knowledge between actors in the clusters. Clusters accumulate formal and tacit knowledge which no single business can fully contain within its organisation. Accordingly, highly specialised knowledge is accessed through networking within clusters, a kind of institutionalisation of knowledge flow which is best captured within the social network approaches.

The social network model developed by sociologists and economic geographers argue that strong interpersonal relationships transcended firm boundaries so that many inter–firm social interactions may be stronger than their intra–firm counterparts. Where there are relationships among individuals who have decision–making power in a group of different firms or organisations, the existence of these trust relationships will mean that the individual or collective actions of the group differ from the behaviour associated with either pure market–contracting or hierarchically organised relationships. Firms within social networks are willing to undertake risky cooperative ventures without fear of opportunism, they are willing to reorganise their relationships without fear of reprisals and more willing to act as a group in support of common mutually beneficial goals. These behavioural features imply that the social network is comprised of transitive private relationships when neither price signals nor monitoring are sufficient to ensure the implementation of a particular project or activity.

The strengths of these relationships is described as embedded–ness of social networks, and in fact all economic relations are socially embedded in the sense that they depend upon

norms, institutions and sets of assumptions shared among a group of actors. They are not simply the outcome of economic decisions. However, industrial clusters reflect an unusual level of embedded–ness and social integration. It is observed that spatial concentrations of social–economic networks tend to be formed knitted to a distinctive historically evolved local economic base with long lasting and strong cultural and personal links among actors. Knowledge is therefore diffused through social relations, and the only way to access this diffusion in–depth is to be part–takers in this institution building. Knowledge flow is thus more than a result of co–location or physical or social proximity. It is better understood as a function of institutional proximity consisting of common norms, conventions, values and routines. In this perspective, pure agglomerations ore pure industrial complexes are much more ideal type models than the social network model that seems to be somewhat closer to real world economics.

Nevertheless, this approach also has its shortcomings. In light of globalisation processes, two processes seem to run parallel, namely that competitive advantage is increasingly attached to knowledge at the expense of input of capital, labour and physical capital, and that we are witnessing a shift in emphasis from building and transferring tacit knowledge towards handling flows of codified information. Recent research seems to imply that due to globalisation and internationalisation, an increasing need for knowledge specialisation is a driving force toward shifting the regional balance of formal and tacit knowledge in favour of formal knowledge. And as firms internationalise, intimate local relationships become less significant. Firms pursuing strategies to develop capabilities outside their home region elect to reorient their level of intra- vs. inter–cluster interaction. Whether this phenomenon is underpinning existing and emerging clusters or conversely, creates diverging learning processes that in the long run have a deteriorating effect on cluster formation, is not clear from existing literature, and the answers would require a whole set of new studies.

At the same time, new conceptual contributions to the field have begun to question the overwhelming emphasis on local interaction and knowledge circulation contained within the cluster as the main source of innovative dynamism for firms in clusters. It is argued that non-local and international links are crucial for knowledge flows in clusters. Recent research also indicates that the flow of knowledge that feed innovation in a cluster is often both local and global. Successful clusters, it seems, are as already mentioned those that effectively build and manage a variety of channels for accessing relevant knowledge from global sources. Resource based approaches have combined the focus on knowledge flow with a more persistent focus

on technological development. In cases where industrial production in clusters are depending on increasingly complex technologies, the production will increasingly also require the support of sophisticated organisational networks situated across a wider array of locations.

This is quite important. As mentioned above, reading the mechanisms and consequences of globalisation on knowledge flow in clusters requires that the concept of institutional setting or framework is widened to look for production and reproduction of such structures and relations that stretches across different spaces and takes place within wider regional or national institutional frameworks. Clusters should be seen as nested within, and impacted by, other spatial scales of analysis, including regional and national innovation systems, as well as the global relationships evolving through the so called pipelines (see above).

The many and still open questions should not overshadow a clear tendency in recent literature, showing that as firms internationalise, they also loosen the systemic relations inside the cluster and interaction takes on a more ad hoc character. Companies that are units of larger companies tend to be more internationally oriented. Firms with operations outside the clusters are, as a group, less embedded within the regional cluster than those lacking external activities. They report less interaction in manufacturing, subcontracting, supplier relations and design. Firms acquired by outside MNCs are also less inclined to interact with the local community.

A deeper insight into this pattern requires an evolutionary perspective on firm growth in clusters. It seems to be clear that there is a correlation between the degree of firms increasing organisational capabilities as they mature, spurred by inwards or outwards internationalisation, and lessened reliance on cluster relations. When elements of local value chains become part of global corporations' value chain, this further even more lessened local reliance. The form of acquisition and degree of subsidiary autonomy, however, matters. Firms that are not integrated into the operations of the MNC report a higher degree of local collaboration.

While recent studies reveal such interesting processes and changing structures, we still know little about the qualitative aspects of the changes, their content and context, and to what extent changes in local interaction changes flow of knowledge as well as the competence base of the cluster and its balance between local and external knowledge. However, the studies generate an interesting possibility for an ideal type dichotomisation concerning the role of MNCs, incoming as well as inside–out companies: namely their role in systemic relations in

the cluster or their presence there mostly for tapping into externalised spill–over mechanisms unfolding in the cluster.

Moreover, it is important to ask whether a shift from systemic to more ad–hoc relations would likely be changing learning processes in the cluster in terms of increasing diverging processes. Organisations characterised by an explicit knowledge base tends to have formal structures of control and coordination and highly standardised tasks and work rules. By contrast, organisations with a tacit knowledge base will exhibit a decentralised structure and use informal coordination mechanisms. Subsequently, hierarchical MNC organisations may internally have certain diffusion structures, competence bases and corporate cultures that make the interaction difficult with the diffusion in clusters dominated by more operative adhocracies that are relying more heavily on knowledge accumulation in external networks. It should be fair to argue that MNCs are more constantly exposed to a form of institutional duality between being in clusters in terms of systemic vs. more ad–hoc relations. It follows also, that if globalisation means more emphasis on flow of formal knowledge and information in cluster dynamics, the balance between actors in the cluster will shift towards storing knowledge in formal structures and routines, hence it will probably render the larger MNCs prominence at the expense of smaller operative adhocracies.

Comparatively oriented case studies conclude that the variables that determine the relative performance of firms in different regions include three especially prominent dimensions: 1) the indigenous mix of institutions and culture in the region, 2) the structure of the industrial system and 3) the internal organisation or industrial culture that prevails in firms in the region. More historically oriented studies have in addition attached a great deal of importance for cluster dynamics to the nature of entrepreneurship, the nature of interfirm relationships and the role of knowledge flows. The most common approach in this setting is intensive case studies of individual clusters (Wolfe and Gertler 2003: 1081, De Martino et al 2006). Such studies have highlighted that although firms in cluster or network systems compete with each other in global markets and collaborate with distant customers and suppliers, their most strategic relationships are local because face to face contact is so critical for rapid product development. [2] More historically oriented studies have in addition attached a great deal of importance for cluster dynamics to the nature of entrepreneurship, the nature of

[2] The Saxenian view that geographic proximity fosters frequent interaction and personal trust needed to maintain these relationships has been challenged by Ganesan, Malter and Rindfleisch 2005 who found no significant correlation between proximity and the development of relational ties in US optic clusters. Their results may strengthen the view promoted by Wolfe and Gertler (2003) and others that building relational ties depends largely on the character of the institutional infrastructure, and cannot be reduced either to frequent face to face communication or to sheer proximity.

inter–firm relationships and the role of knowledge flows (Kenney 2000 and Lee et al 2000, referred to in Wolfe and Gertler 2003: 1082).

Michael Porter, otherwise known for sophisticated statistic mapping of clusters, has also conducted a number of in–depth case studies of five US regions. In–depth interviews with leading actors in the clusters were an important part of the case studies. In conclusion, clusters emanate from a unique mix of localised assets, and evolve over decades. Moreover, the studies demonstrate that collaborative formal and informal institutions first and foremost facilitate the flow of knowledge, ideas and resources among firms and supporting institutions (according to Wolfe and Gertler 2001: 1083).

Wolfe and Gertler (2003: 1084) sort out seven key features that should be emphasised in studying globalisation and cluster development: 1) the size and composition of that actual clusters, 2) the history of the clusters evolution, including key events, both intentional and accidental, 3) the nature of relationships between firms and between firms and research infrastructure, 4) the geographical structure of these relationships, 5) the role of finance capital, 6) the role of local associate behaviour and 7) other forces contributing to or inhibiting the growth of the cluster. Within this wide framework they say that current literature "have led us to emphasize flows and dynamics over stocks and static measures of innovativeness". They point quite clearly to the "centrality of knowledge and learning processes, both embodied and otherwise" (p. 1084). Central to their studies of Canadian clusters have been inflows, outflows, local social dynamics and historical path dynamics.

About inflow, they say that "One clear way to confirm the existence of unique, distinctive local knowledge based assets is by tracking three different flows of inflow. Capital inflows, in the form of venture capital investments, foreign direct investments, or mergers and acquisitions, indicate that investors have identified the local presence of local knowledge assets and capabilities." (p. 1084). Hence, in order to identify the effect of globalisation on knowledge flow in clusters we need to ask the parent companies of their motives for cluster localisation. According to Wolfe and Gertler (2003), "Inflows of people are an especially robust indicator of local dynamism. It is now increasingly well established that highly educated, talented labour flows to those places have a "buzz" about them – the places where the most interesting work in the field is currently being done" (p. 1084). In–bound talented labour force represents knowledge in its embodied form flowing into the region, and such flows act to reinforce and further accentuate the knowledge asset already accumulated in the region. In other words, what is it about local knowledge flow that attracts inflow of talents to the cluster? Outflows can be tangible (export of goods from the cluster) or intangible, like

flow of knowledge through various forms of formal modes like licensing or patent citations: “We would argue that this kind of activity provides perhaps the best indicator of wider recognition of the unique capabilities and knowledge assets of a region”. (p. 1084).

When it comes to local social dynamics, Wolfe and Gertler (2003) argue, based on comprehensive cluster studies, that informal monitoring of other firm’s activities as well as learning through the circulation of labour among firms is a relatively more important source of knowledge flow than formal collaborations among local firms or dense networks of buyer–supplier relationships. (p. 1085). Also, community level institutions that promote associative governance are of great importance in the sense not the least that they can promote a kind of reflexivity within the cluster thus increasing its adaptability facing external challenges or opportunities.

Nevertheless, they argue that “the most discerning test of ‘true’ cluster dynamics is one that assesses the alleged cluster’s resilience and robustness over time, in the face of severe shocks and dislocations. How has the region fared under such circumstances? How effectively have its firms and institutions adapted and evolved in response to such pressures for change?” (p. 1085). They find that recognising and learning from failures is a prominent feature of successful clusters, so that among other things, potential investors see entrepreneurs who have experienced past failure as a possible source of future expansion. Less dynamic regions, on the other hand, tend to squander such opportunities by permitting or encouraging out–migration.

8. Convergent vs. divergent patterns of knowledge sharing in clusters

As outlined in the first parts of this paper, recent Porter–inspired accounts of globalisation and its impact on knowledge sharing in the regional maritime cluster in Møre and Romsdal in Mid Norway seem to stress a convergence picture (see also Rech 2006). Globalisation as well as internationalisation have strengthened cluster relations and led to intensified interaction between local players and between local and global actors (Hervik et al 2006). We have then contrasted these national and regional accounts with international literature in order to investigate whether this convergence story is constructed thematically so that convergence can be assessed. Although we are facing problems in terms of comparability and compatibility between international cases, and between such cases and Møre and Romsdal, it seems evident that assessing converging vs. diverging cluster learning patterns requires a number of themes to be raised that are not encompassed in the actual regional

studies. In general, we have argued that cluster frameworks should be balanced against business strategy frameworks, or a deeper understanding of knowledge transfer inside the incoming global actors in the region according to their motivation for being attached to cluster dynamics and how such dynamics are anchored in the actual companies' growth strategies. Straightforwardly put, it is impossible to understand what is going on in the cluster unless we understand more of strategies and knowledge transfers inside the global companies.

We have reason to believe from various international cluster studies that flow of global and formal knowledge through pipelines and non–local knowledge linkages is becoming more apparent in cluster dynamics at the expense of flow of local tacit or synthetic "sticky" knowledge through local buzz. This pattern is allegedly related to the increasing presence of MNCs in clusters, which again promotes less reliance on knowledge creation and flow through local institutional frameworks and more reliance on ad–hoc presence to reap the benefits from knowledge spill–over. Moreover, it is suggested that internalisation and formalisation of knowledge flow is gaining importance at the expense of reliance on knowledge residing in the regional cluster and that this may have a deteriorating effect on the cluster.

In consequence, this means that we, ideally, would have to study the motives of the global actors, the acquisition history, integration of the subsidiaries into global strategies or value chains, or subsidiary autonomy conversely, and their growth strategies. In light of dissemination theories briefly outlined above, urgent questions will be to ask mangers inside the global corporations whether incoming global actors fosters new managerial networks at the expense of more traditional cluster based managerial networks, and conversely, ask regional managers whether their networks have been extended by the presence of global actors so that they foster beneficial global–local managerial networks. Furthermore, we need data that may give solid information about these managerial networks in global pipelines and local buzz. Are they drivers of knowledge transfer through pipelines through fostering global value chains and development and innovative projects of a more strategic nature? Does this imply more closed membership in strategic project teams, at the exclusion of the open membership system characterizing clusters? Who joins the projects and who are excluded? Are new managerial networks acting as gate–keepers that filter knowledge flow and limit its circulation inside the cluster?

In the same vein, we should ask whether we are witnessing emerging asymmetries in knowledge flow in the cluster. Are local actors feeling that they give more information to the global actors than they receive from them? Have new managerial networks established a more

prominent and controlling position in local institutions, like centres of expertise, management development programmes and networks, and educational networks, so that they in a superior manner can monitor innovative ideas emanating from cluster dynamics, affect innovation processes to suit corporate strategies? Or are they on the contrary withdrawing from local networks and institutions? Do local and global actors alike confirm that global actors establish powerful relations in the cluster based labour market, so that they through various mechanisms (like grand regional campaigns we have recently seen or through the power of wage setting) recruit the most operative technical–managerial workers? Does this pattern in fact converge with increasing weight on internal labour market, internal competence building, and internal mobility and flow of knowledge? Moreover, does this imply that encoded knowledge and transmission of formal knowledge gain more importance in cluster dynamics as well?

We believe these questions to be the most important in order to assess the regional flow of knowledge in light of globalisation and determine to what extent we are witnessing regional converging or diverging learning patterns. In this respect we should, ideally, approach 1) a smaller selection of global companies in the cluster that represents different but complementary segments of the cluster, 2) a selection of central "institutional" actors in the cluster and 3) a selection of a few companies which have extensive contact with the global companies, but which themselves mainly have a regional strategy and orientation (important control group).

As we have seen through this paper, the context in which changes takes place is important (background variables, independent variables). Such variables would be what type of cluster we are studying (especially its knowledge base (synthetic knowledge base), historical and empirical data on recent globalisation processes and internationalisation, cluster structure and actors and shifting power relations (offshore supply vs. deep sea fishing). Much of this is already available through cluster studies (like Hervik et al 2004, 2006) or through in–depth studies of specific sectors (like fishing and offshore supply, Isaksen 1999, Bjarnar 2006, Berge 2006). Different cooperative patterns in the cluster up to the present are already accounted for in these studies, like cooperation in production related (manufacturing), degree of interaction with other manufacturers, skilled workers, degree of informal relationships in systems related activities, vertical buyer–supplier links and horizontal structures.

However, we need to fill in the picture of the companies' perception of external local linkages vs. non–local knowledge linkages, and the institutional actors in the cluster's

perception of local vs. non–local knowledge linkages (assessments based on interviews and reinterpretation of existing survey studies): the perceived degree of local collaboration vs. international collaboration, local end users vs. international end users, perception of knowledge sharing through non–local external linkages/channels vs. external local linkages/channels, perception of synergies between non–local and local linkages, perception on role in regional/local institution building, how they value the local knowledge pool, and has the company withdrawn itself from any local network? To what extent/degree do the global companies ascribe importance to local collaborators (companies, suppliers) vs. importance to internal or global collaborators? To what extent/degree do local companies (or institutional actors) ascribe importance to the global companies vs. other local companies?

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