

# **Challenging Clusters**

## ***The Prospects and Pitfalls of Clustering for Innovation and Economic Development***

### ***Summary Report from an AIM Management Research Forum in Cooperation with the Welsh Economy Research Unit***



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A large, light blue abstract graphic that resembles a stylized arrow or a cluster of points, pointing towards the bottom right. It is positioned behind the text on the right side of the page.

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ISBN No: 0-9546885-7-0

**June 2005**



# 1 Preface

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It is Department of Trade and Industry (DTI) policy to create the conditions that encourage the formation and growth of clusters. It sees clusters “as concentrations of competing, collaborating and interdependent companies and institutions which are connected by a system of market and non-market links” ([www.dti.gov.uk](http://www.dti.gov.uk)). A broad range of benefits are expected to arise from the facilitation of clusters. However, these benefits are often not specific to clusters and sometimes don’t materialise at all.

So, how do clusters benefit businesses and the wider economy? On 13th April 2005, the fifth AIM Management Research Forum discussed the evidence on clusters and their impact on aspects of regional development, innovation and economic performance. Held in Cardiff in cooperation with the Welsh Economy Research Unit, participants explored the challenges of putting ‘policy into practice’ in a regional context, following engaging presentations from Professor Rick Delbridge of AIM and Cardiff Business School, Calvin Jones of the Welsh Economy Research Unit and Robin Gallimore, Centre Director, HP Labs Bristol, and Director, Digital Media Systems Laboratory.

The key objectives of the Forum were to scrutinise the empirical evidence on clusters and the extent to which they deliver on purported benefits, to provide a forum at which the challenges of putting ‘clusters policy into practice’ could be assessed, and to contribute to debates over whether clusters can be created or managed.

This report explores these issues by drawing upon an open and insightful forum discussion and further desk research, undertaken by a team of AIM Scholars. The AIM Scholars have sought to integrate the latest and best academic thinking from around the world with the conversation and discussion that took place at the Management Research Forum. In light of this they have developed specific policy recommendations and identified outstanding research questions that require further investigation.

We hope you find the report of interest and that it will stimulate your thinking and encourage you to become involved with AIM Research and its future events.

Professor Andy Neely

Deputy Director  
Advanced Institute of Management Research

Professor Max Munday

Director  
Welsh Economy Research Unit  
Cardiff Business School



# Executive Summary

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Clusters are systems of localised economic activity and innovation. This report reviews current evidence on clusters and develops policy recommendations for the UK. It argues that clusters include multiple firms from related sectors that are co-located within a web of complex linkages and a support infrastructure. We find that:

- Clusters matter because they have the potential to increase innovation in and between firms, raise productivity and competitiveness and hence contribute to regional and national economic growth.
- Clusters emerge spontaneously, taking advantage of existing local endowments or economic conditions in a variety of ways. They are heterogeneous in nature and there is no evidence that sustainable clusters can be created where no competitive advantage exists.
- Cluster development relies upon the creation and attraction of firms, which implies both access to capital and a positive attitude to risk.
- Clusters grow by taking advantage of proximity, shared and specialised labour markets; knowledge creation and transfer; a network of support services and a complex fabric of social relationships.
- A successful future for clusters will depend upon their ability to respond to the globalisation of production and markets, and the diffusion of information and communication technologies. There is a need for firms in clusters to be receptive to new sources of knowledge and innovation from outside the established cluster.

## Policy Considerations and Recommendations

Cluster policy in the UK is currently fragmented and lacks a coherent framework and clear objectives. This report suggests a number of considerations and recommendations that should define cluster policy.

### Principles for cluster policy:

- Focus on systems of economic activity or product families rather than on industrial sectors.
- Adopt a long time-frame that reflects the life cycle of clusters and recognises that cluster development may be measured in decades rather than years.
- Restrict to circumstances where there is enough economic and social capital and embryonic cluster features are present.
- Take a coherent and consistent approach over time and space in terms of concepts and language, taking into account the specificities of the local context.
- Use lucid evaluation tools and mechanisms that deploy both qualitative and quantitative performance measures.

### The dynamic nature of clusters:

Clusters undergo a life-cycle, and policies need to be tailored to fit different requirements over that life-cycle. This means:

- Provide a context for cluster emergence that encourages entrepreneurship, capital provision and skills development. Hence, good economic policy more generally may provide triggers for clustering.
- Encourage embryonic clusters through the provision or enabling of physical, human and network capacity, or information dissemination.
- Intervene to enhance cluster development where there is a specific development challenge and/or bottleneck, for example, by providing suitable physical or training infrastructures.

### The institutional co-ordination of cluster policies:

Cluster policy requires co-ordination among national and regional policy makers. The provision of coherent policy frameworks as well as tools for analysis, evaluation and interventions is best undertaken at the national level, as this allows for co-ordination of regional efforts. The Regional Development Agencies (RDAs) are best placed to work with specific clusters, evaluate policy options and work with firms and other organisations to help sustain competitive clusters. Co-ordination between different RDAs is required to avoid overlaps and wasted effort.



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# 1 Introduction

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The increasing globalisation of economic activities has illustrated a tension between the global, national and local dimensions of economic development. As markets have become global, so has the division of labour across firms, with the latter becoming multi-national, multi-plant and multi-sectoral. The global dimension of production and innovation processes has increased the need for localities to exploit their competitive advantage and position themselves in the global market. Although firstly this affected manufacturing activities, increasingly services are subject to global competition too. The local dimension of global competition leads to a “geographical hierarchy of regional centres” (Cantwell and Iammarino, 2002: 293); that is, the ranking of regions according to their competitive advantage and their local competences. Globalisation has, therefore, exacerbated the divide between core and peripheral regions, and between competitive and less competitive regions.

According to the EU Commission (EC), regional business competitiveness is the:

*“...capacity of a regional economy to generate, diffuse and utilise knowledge and so maintain an effective regional innovation system; a business culture which encourages entrepreneurship and the existence of cooperation networks and clusters of particular activities” (EC, 2004, p.37)*

The attention of policy-makers has hence shifted towards the question of how the competitiveness of regional and local economies can be improved. Within the context of the wider academic debate on regional development and regeneration, it was suggested that one of the sources of competitiveness for localities is the presence of clusters defined as systems of co-located firms and institutions specialised in one or a few related sectors (Porter, 2000; Cossentino *et al.*, 1996; Becattini *et al.*, 2003). This has meant that clusters have entered the policy-making vocabulary either as a target for economic policy, or as a means of furthering local economic development. For instance, the DTI suggests that:

*“competitiveness increasingly relies on a country’s appropriate structures of roles, institutions and processes to enable, organise, and drive efforts to improve business environment and clusters”. (Porter and Ketels, 2003, p.30)*

In the UK, the Regional Development Agencies have taken on board the cluster agenda and many now include the promotion of clusters in their economic strategies. The West Midlands RDA (AWM) considers, for instance, the promotion of business clusters and high-technology corridors as key delivery mechanisms for the broader aim of pursuing regional growth and economic inclusion (Advantage West Midlands, 2004).

Given the interest in clusters highlighted above, a more thoughtful analysis of the role that clusters can play in enhancing the competitiveness of a region (or a country) seems paramount. The purpose of this report is indeed this: Firstly, to assess the value and contribution of the cluster concept in light of a boundary-spanning academic debate on regional development that draws upon several disciplines, and, secondly, to evaluate the role clusters can play within local, regional and national economic development policies.

The structure of the report is as follows: Section 2 defines the notion of cluster, while Section 3 assesses the importance of clusters for local growth. The dynamics of clusters, as well as their prospects and pitfalls in an economic context where globalisation is the main imperative, are analysed in Section 4. Policy conclusions are drawn and research recommendations given in Sections 5 and 6.

## 1.1 How the Report was Devised

Five AIM Scholars were selected to engage in and facilitate the discussion at the Management Research Forum and subsequently to produce the report in collaboration with AIM Senior Fellow, Professor Rick Delbridge, and AIM staff. The people involved in the project include:

[Dr. Pierpaolo Andriani, AIM Scholar, Durham Business School](#)

[Mr. Calvin Jones, AIM Scholar, Cardiff Business School](#)

[Dr. Markus Perkmann, AIM Scholar, Warwick Business School](#)

[Dr. Lisa De Propriis, AIM Scholar, University of Birmingham Business School](#)

[Dr. Vania Sena, AIM Scholar, Aston Business School](#)

[Professor Rick Delbridge, AIM Senior Fellow, Cardiff Business School](#)

[Dr. Kathrin Möslein, AIM Associate Director](#)

[Professor Andy Neely, AIM Deputy Director](#)

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## 1.2 What the Report Contains

This report is the result of the team's reflection on the discussion at the Management Research Forum and subsequent desk research. The report does not attempt to provide a comprehensive or systematic review of the literature in the field. It aims to map the field in a way that gives a fresh perspective, based on insights from all the participants at the Forum, and to move forward the discussion on the prospects and pitfalls of clustering for innovation and economic development. The overall objectives of this report are to:

- Scrutinise the empirical evidence on clusters and the extent to which they deliver on purported benefits.
- Provide an opportunity to assess the challenges of putting 'clusters policy into practice'.
- Contribute to the debate over whether clusters can be created or managed.
- Present policy recommendations to inform public discussion.
- Present research recommendations that could feed into academic enquiry.

## 2 What is a 'Cluster'?

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In some quarters, the cluster concept has recently attracted more scepticism than enthusiasm. It could be argued that it is just another one of the labels and definitions that have been used for *local systems of economic activity and innovation*. In fact, there has been an inflation of such labels, generating confusion and putting a question mark over the role they can play for local economic development (Martin and Sunley, 2003). But there have also been attempts to bring some clarity to the debate, and several authors have suggested useful typologies for characterising different realities of local production systems (Markusen 1996; Gordon and McCann 2000; Simmie and Sennett 1999; De Propriis and Driffield 2005 forthcoming).

In the following, we build on these contributions and identify four broad categories of local production systems: industrial districts, Porter's clusters, innovative milieux and networks. Further, below we extract the common characteristics from these definitions to arrive at the concept of clusters as used in this report.

Becattini (1990:38) defines the **industrial district (ID)** as "a socio-territorial entity characterised by the active presence of a group of persons and a population of firms in a given historical and geographical dimension". In this definition, an ID appears to be characterised by the strong interplay between the fabric of social relationships and network of economic/production exchanges (Becattini, 2004). Overlapping production and social linkages facilitate information and knowledge sharing, trust and cooperation. Furthermore, firms and people are embedded in a socio-cultural context that generates dynamic processes of knowledge creation (learning and innovation) and knowledge transfer (diffusion and synergies).

Porter (1998:3) describes **clusters** as "*geographical concentrations of interconnected companies and institutions in a particular field*". More recently he added to the definition the fact that firms compete as well as cooperate among themselves (Porter, 2000). By and large, Porter's clusters appear as a spatial agglomeration of firms bound together by input-output exchanges on the basis of their production complementarities. The benefits generated in Porter's clusters stem from the external division of labour across firms.

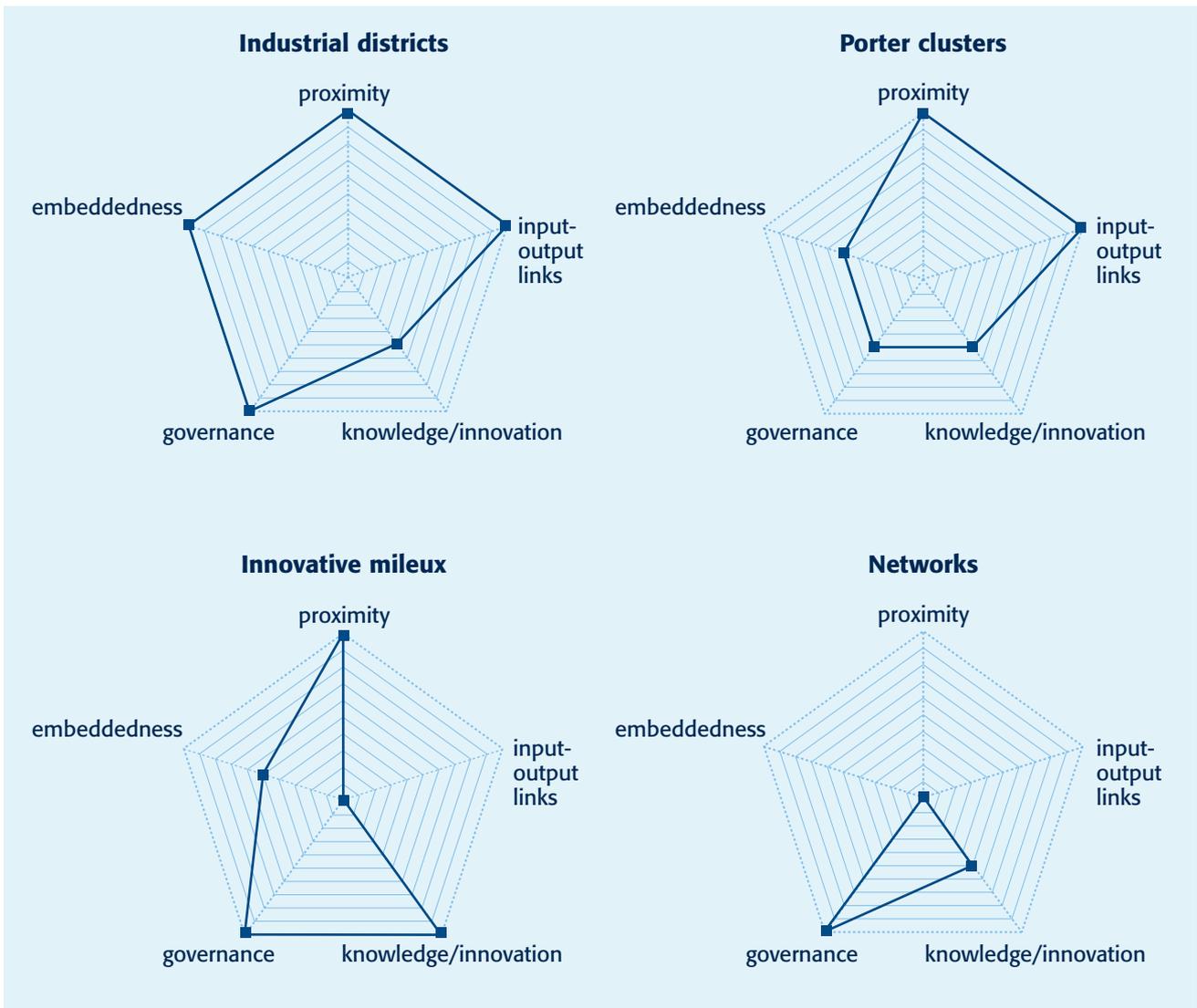
**Innovative milieux** are characterised by geographical proximity, informal relationships between firms and collective learning processes (Camagni, 1995). In these innovative *milieux* the structure and the dynamics of inter-firm linkages (not necessarily vertically along the supply chain) are purposefully aimed at generating innovation, more specifically systemic innovation. Production exchanges between firms in these *milieux* can be minimal and competition between firms can dwarf cooperation. However, co-location, embeddedness, and the presence of both a skilled local labour market and research facilities shared across the *milieux* ensure knowledge sharing and systemic learning.

Finally, the Scandinavian School has developed a stream of research focused on **networks** (Håkansson, 1987; Bjorg and Isaksen, 1997), these being systems formed by hubs (firms and institutions) connected via linkages (i.e. cooperative relationships, production exchanges etc) which do not have to be necessarily co-located. In fact, clusters comprise several networks, including:

- (a) A network of social linkages that leads to the development of social capital (Putnam 1993);
- (b) Networks of input-output linkages/exchanges; horizontal networks of joint activities, e.g. innovation, marketing;
- (c) Networks of policy support across firms and institutions. Such networks do not have by definition spatial borders, but can have a local, national or global dimension according to the location of the hubs and the linkages connecting them. A good example is the automotive network in the UK, which is at least part of the EU (if not global) auto industry.

The four definitions provided in the academic literature suggest that clusters can take different forms according to how they differ across five main dimensions: proximity, input-output links, knowledge/innovation, the distribution of decision-making power (governance) and embeddedness. **Figure 1** provides a synthesis of the main features and thereby differences between the above mentioned types of clusters. For instance, innovative milieux have the greatest capability for innovation and knowledge creation generated by multiple information channels and dynamic learning processes. On the other hand, Porter's clusters have a more hierarchical governance structure than the other three forms of clusters as they are focused on production exchanges and the presence of both large and small firms, often resulting in a 'hub and spoke' structure.

Figure 1: Types of local production systems



The spider diagrams indicate the degree to which specific dimensions are emphasised by different clusters concepts. Rather than add another label to the ones already known, we synthesised the key aspects that are common to all types of clusters beyond the differences highlighted in the literature.

Accordingly, clusters are characterised by:

- A critical mass of firms and institutions co-located in the same geographical area and specialised in a set of interdependent economic activities.
- Spatial proximity is also associated with firms’ organisational proximity, cultural proximity and cognitive proximity.
- Firms which specialise in different aspects of the value chain; because of their complementarity, firms are therefore integrated in an external division of labour resulting in networks of input-output relationships.
- Firms are embedded in dense networks of untraded (social and cultural) interdependencies – in addition to input-output relationships – that generate opportunities for mutual learning and enhance the levels of trusted co-operation.

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- Relatively distributed decision-making processes which do not have clear hierarchical features (i.e. flat governance structure).
  - Institutional thickening; that is, the emergence of public and private institutions and organisations able to support the growth of the cluster by making available services and initiatives.

Although clusters share these characteristics they can vary significantly. In particular, they might differ as to how the cluster is governed, its degree and direction of specialisation, the role of public organisations, the division of labour and the organisation of innovation and learning processes. For instance, even in advanced industrialised countries, some clusters specialise in relatively traditional manufacturing goods (tiles, shoes), while others are 'high-tech' clusters competing in the global software or biotechnology industry. Whilst in the former, on-the-job learning and vocational learning are very important for ongoing learning, in the latter, higher education institutions and formal R&D play a more dominant role. As will be argued below, policies need to be tailored to fit the characteristics of clusters at hand as there is no one-size-fits-all policy for all clusters.

Clusters should not be confused with sectors. Although each cluster is associated with a final product (which is reflected in a specific SIC sector classification), e.g. textiles or jewellery clusters are by definition multi-sector (or cross-sector). See, for instance, Porter's description of the California wine industry in Porter (2000); Lazerson (1990)'s analysis of the network of subcontracting in the textile industrial district in Modena (Italy) and Henry *et al.* (1996)'s mapping of economic activities in the British motor sport industry. Clusters ought to be seen as a pool of inter-dependent and complementary competences associated with related manufacturing and service activities rather than simply as a "sector". The production chain that leads to a certain final good often embraces several manufacturing and service sectors all related and tailored to the core activity of the cluster (Becattini, 2002). For instance, marketing/advertising firms in a cluster would customise their services to the specific needs of the firms in the cluster. This means that policy-making has to take a broader view than just focusing on specific SIC-classified sectors and to consider the whole spectrum of manufacturing and service activities associated with a certain cluster.



## 3 Why do Clusters Matter?

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In this section of the report we use insights from the literature to address the following question: why do clusters matter? The brief answer to this question is simple. Companies located in a cluster can experience higher productivity improvements than their counterparts not located in clusters (Glaeser *et al.*, 1992). From the perspective of the economy, productivity improvement promotes economic growth and competitiveness.

The simplicity of this answer, however, prompts additional questions such as: What are the sources of higher productivity growth of firms located in a cluster? How can these productivity gains engender higher growth in the whole (regional or national) economic system? What are the welfare implications of a polarised growth process where most of the productivity gains necessary for growth are actually made in spatially bounded areas?

### 3.1 Productivity and Clusters

Research has identified several potential sources of faster productivity growth for firms operating within clusters. These include:

- The existence of increasing efficiencies for firms that arise from co-location, for example from knowledge transfer (so-called *dynamic externalities*); this allows the companies to have access to a common pool of resources (in particular, a specialised labour force) and to a dedicated network of suppliers and customers which minimises search costs.
- High rates of innovation and creativity, due to the existence of knowledge spillovers as well as shared sets of values and often unwritten norms that generate trust and a sense of embeddedness.

Scholars of Economics are unanimous in considering the first, dynamic externalities, as the main source of increasing productivity growth for firms located in a cluster. As these externalities arise from the interaction of economic agents, these effects are obviously more pronounced when agents are in close physical proximity. Glaeser *et al.* (1992) suggest three types of dynamic externalities. The first is labelled Marshallian or MAR (Marshall-Arrow-Romer) externalities. Marshall (1890) identified knowledge spillovers, labour market risk pooling and vertical linkages as the main sources of increasing returns to scale for firms that belong to the same industry. Knowledge spillovers can generate increasing returns to scale by reducing the costs of acquiring knowledge for the firm, whilst immediate access to a specialised labour market and privileged access to a network of suppliers and customers allow the company to reduce substantially the costs of searching for suitable workers and suppliers (so-called “matching costs”). Labour pooling occurs when firms compete for workers. As workers are drawn to a region with multiple employment opportunities, firms benefit by having access to a large and appropriate set of potential employees from which to draw upon. The existence of a labour pool, if tied to technical or vocational training facilities, may raise the general worker skill levels and reduce the transaction costs associated with firms conducting employee searches. The same is true for the access to a specialised network of suppliers and customers. Firms in close proximity can monitor suitable suppliers or customers and this allows them to further reduce the transaction and search costs. Therefore, Marshall suggests that firms that use similar technologies, inputs and types of workers may decide to co-locate to take advantage of these economies.

The second type of dynamic externality is known as urbanisation economies (Jacobs, 1969). These suggest that firms may experience increasing returns to scale by co-locating in clusters with a diverse industrial structure. For example, firms in a high-tech industry may benefit from technological developments that take place in other industries with which there are some technological synergies. Therefore, firms benefit from urbanisation economies, in terms of faster productivity growth, when they are located in highly diversified clusters.

Finally, the third type of dynamic externality is associated with Porter (1990). As in the case of MAR externalities, it is argued that industrial concentration stimulates productivity growth and that local competition fosters innovation and the dissemination of information.

Interestingly, there has been a long debate in the cluster literature on the relative importance of the different types of externalities in explaining the faster productivity growth in clusters. Indeed, Henderson (1988) finds that MAR economies are more important than urbanisation economies in clusters. However, Glaeser *et al.* (1992) found the opposite result, casting some doubt on the MAR economies as a source of growth for clustered firms. Additional empirical studies have provided ambiguous evidence, with some authors finding both the MAR and the urbanisation externalities strong in one sector and weak in another (see Combes, 2000, Dekle, 2002, Henderson, 2003).

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Qualitative studies on clusters show that a mix of both MAR and urbanisation economies can be vital for the success of a cluster (See case study 1 for the case of the Brazilian and Mexican shoe clusters). It has been suggested that whether an industry benefits most from urbanisation or MAR externalities depends on whether or not it is in a mature sector: new dynamic industries can benefit mostly from the cross-fertilisation provided by other companies in other sectors, while mature industries can take advantage of the MAR economies (World Development Report, 2000).

**Case study 1: The Brazilian Shoe Cluster of Sinos Valley and the Mexican Guadalajara and Leon Clusters**

*In 1992 Brazil ranked as the world's third biggest exporter of leather shoes. The most dynamic Brazilian region for shoe production is the State of Rio Grande de Sul where the cluster of Sinos Valley – the centre of Brazil's shoe industry – is located. The reasons for the Sinos Valley's economic success lay in the existence of a) deep backward linkages that shoes producers had with local suppliers of inputs, machinery and producer services and b) strong forward linkages between producers and buyers. The cluster is also characterised by the existence of a mix of MAR externalities (as most companies in the same shoe industry are located in the area) and urbanisation economies (as suppliers of raw materials and second-hand machinery are also located in the cluster).*

*The success of this cluster is in contrast with the lack of dynamism shown by two shoe clusters located in Mexico. As in Brazil, shoe making in Mexico was spatially concentrated. There were two specialised clusters each producing distinct types of shoes. These were Leon and Guadalajara. In spite of being closer to the US market and operating in sectorally specialised clusters, the Mexican shoe sector had not been as competitive as the Brazilian and it was assumed that the potential offered by clustering through inter-firm ties had not been fully exploited in the Mexican shoe clusters. The main reasons for this weakness are the scarce backward and forward linkages with the other firms of the same and other sectors. Indeed, despite their long history in shoe making, both clusters fared poorly in terms of linkages with a technically well developed supply industry producing components and machinery used in shoe making. Equally, marketing and commercialisation is also weak in the Mexican shoe cluster (Nadvi, 1995).*

In spite of the apparent conceptual differences, the three notions of dynamic externalities share common elements. In all cases knowledge spillovers are critical in sustaining a higher rate of innovation and therefore, among other things, productivity growth for clustered firms. Knowledge can be considered an 'impure' public good that generates spillover effects across firms. Hence, if economic agents have different pieces of information, pooling them through informal communication channels can benefit everyone. This emphasises the role of proximity within innovative processes (Glaeser, 1999).

Knowledge can spill over to other companies through several mechanisms. A first group of studies assumes that spillovers might be embodied in either intermediate-input flows or patent-flows between firms (or industries) (Nadiri, 1993). For example, if two firms are involved in the same vertical relationship, the innovative efforts of one firm will provide the other with higher quality inputs, thus allowing it to increase productivity.

Alternatively, knowledge may spill over through a single firm's investment in R&D. Indeed it is a well-known feature of R&D investment that firms are unable to capture all the benefits of their investment (Nordhaus, 1962). Innovations can be readily imitated by other firms (once patents have expired). There is evidence that within the same industry, some firms devote resources to either the improvement of current products and processes or the discovery of new products, while the remaining firms are devoted to copying the success of the innovative firms, as reproducing knowledge is often cheaper than producing it. In the case of firms in the same industry, knowledge spillovers mediated through R&D occur as both the innovator and the imitator are likely to share the same technology. However, *inter*-industry R&D spillovers are also possible as long as firms in the different sectors are technologically similar or share a common technology base. Indeed, in several papers, Jaffe (1986, 1989) provided empirical evidence on the inter-industry spillover effect in the US manufacturing.

Finally, a third group of studies suggests knowledge spillovers may be facilitated by geographic proximity. In this case, technological knowledge can spillover through a set of formal and informal contacts, such as industry clubs, conferences, talks and seminars, made possible because firms (and more importantly, individuals working for them) share the same location, something which decreases the cost of participation in these activities. On these occasions, potential adopters of innovations (who have limited information about costs and benefits of the innovations) come in

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contact with existing users, so the diffusion of intangible technological capabilities is promoted. The implicit assumption is that there is a specific type of knowledge, which cannot be patented and that therefore can only be transmitted through direct contacts between the source and the recipient (this is also labelled as “tacit knowledge”). This is typically true for basic research that generates new fundamental ideas. In spite of the fact that the core work can be made available through normal public codified channels (e.g. scientific journals), there is still a considerable portion of the research which can only be conveyed via direct interaction and discussions with scientists (Poyago-Theotoky *et al.*, 2002). To quote Feldman (1994, p.2), “knowledge crosses corridors and streets more easily than oceans and continents”. Knowledge can also spill over through skilled workers’ mobility across companies. Workers’ mobility affects the cluster’s supply of tacit or non-standardised knowledge. While the theoretical notions of tacit knowledge are sometimes poorly substantiated, it is a fact that it ultimately rests with individuals; therefore, the movements of workers across firms in the cluster allow consequent productivity improvements. Indeed, evidence suggests that for firms whose operations are almost entirely dependent on the quality of human capital, a steady stream of incoming labour is crucial for development (Saxenian, 1994).

The second factor positively affecting productivity is a higher rate of innovation compared to non-clustered firms. Before going into detail, it should be noted that the benefits of innovation are not limited to productivity increases. Innovation involves the launch of new and better products that might offer absolute advantages to customers, hence open up new markets and re-direct income streams for producers. Depending on their specialisation, these processes of ‘creative destruction’ bring opportunities or threats to particular clusters and can hence trigger structural changes in the economies concerned.

The distribution of innovative activities in advanced countries is highly localised and a relatively few centres around the world are responsible for large parts of science and technology production. A cluster exists because innovation is fundamentally a sticky process, which requires an institutional setting made of companies, institutions, rules of competition and cooperation, distribution and quality of skills and knowledge. This and the effects of new technology discovery and diffusion reinforce the organisational logic of the cluster, triggering in this way, further discovery and further innovation. In this process, the set of norms and values that governs interactions between economic agents and institutions (or social capital) facilitates and contributes to the high rate of innovations experienced in a cluster. In economic terms, this equates to the set of rules and habits that facilitate market exchange and the innovation process, by reducing transaction costs and ensuring that contracts are observed and implemented. In the context of a cluster, social capital can help to reduce the costs of acquiring information on current and future partners. It makes it easier to reduce the incidence of free-riding and facilitates the cooperation among firms in the cluster. If we also consider factors such as reputation, reciprocal trust and a sense of working towards a common purpose, then the role of social capital is to create a climate that encourages responsibility, cooperation and synergy. Thus by stimulating creativity and providing public goods like trust, the rate of innovation is enhanced.

### **3.2 Economic Growth and Clusters**

In this sub-section, we analyse the importance of clusters and clustering for regional (and national) economic growth. Research on the sources of economic growth has evolved substantially in the last fifty years and it is possible to distinguish two distinct views on its dominant drivers. According to the first view, regions and countries that have more physical capital grow faster and grow wealthier (Solow, 1956). This implies that all the impediments to investment in physical capital must be removed and incentives given to increase the savings that are used to fund a higher investment rate. The second view is labelled ‘endogenous growth theory’ (Romer, 1986; Lucas, 1988). This view challenges the pivotal role given to physical capital in promoting growth by Solow and considers Total Factor Productivity (TFP) growth (or the increase in the production following the increase in the productivity of all the production factors) as the engine of economic growth more generally. This implies that not only does physical capital accumulation contribute to the growth of a region, but also that other production factors (like labour, R&D and materials) can contribute to the growth of an economy. While in the Solow model, TFP is considered a measure of “our ignorance”, now it becomes the key variable for understanding the growth process. Thus all the economic factors that can have an impact on productivity growth may play a potential role in promoting growth; among these, investments in infrastructures, investments in human capital, innovation and investment in R&D have all been considered by economists as being good candidates to promote economic growth (Helpman, 2004). In the light of these considerations, the link between economic growth and clusters is obvious: as clustering allows firms to

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experience higher TFP growth than otherwise, then the existence of a cluster may let a region or a country experience faster economic growth than it would in the absence of clusters. This point is relatively uncontroversial at least at the theoretical level although the exact quantitative impact of clustering on economic growth has not been extensively studied. However, there are other issues regarding the relationship between clusters and economic growth that are worth exploring. By definition, clustering implies that there is an area of a region (or of a country) whose higher GDP per capita is obtained at the expense of a peripheral area, as both workers and firms should prefer to locate in the clustered area where they can both benefit from higher wages and higher TFP growth. It is therefore interesting to understand both how the process of economic growth affects this core-periphery pattern over time (that is whether regional disparities may increase over time as the economy grows) and also to what extent the outcome of this polarisation process is socially desirable.

To answer these questions, we can consider an economy where growth is driven by innovation produced in a cluster of high-tech firms hiring skilled workers (Fujita and Thisse, 2002). In this environment, economic growth is affected by the spatial organisation of the high-tech firms: the more clustered the firms are, the faster the growth process. In addition, agglomeration forces can be so strong that the entire high-tech activity can concentrate in a single region and, more importantly, this spatial organisation can be stable and persistent over time. Growth and clustering go hand in hand and they are self-reinforcing, creating a 'multiplier' effect where initial clustering will imply a faster growth process, that in turn will enhance the clustering process through a circular process involving market size, access to suppliers, transportation advantages and so on (Krugman, 1998), leading to regional differentiation and spatial concentration of wealth. However, while this result seems to suggest there is a trade-off between growth and equity, it is important to recall that the additional per capita GDP created by the clustering process may be used to make sure that those who are in peripheral area are still better off than in an economy without clustering processes. So the unskilled workers who live in the periphery of the economy (or region) can still enjoy a high living standard thanks to transfers from the core region. The policy conclusion from these considerations is obvious: while clustering is important in allowing a region (or a country) to grow faster, policies have to be designed so that a) the advantages of the extra growth can be distributed across the whole region and b) provisions have to be made to make sure that the living standard of those who live in the periphery is not hurt by the slowing growth process due to the economic cycle.

## 4 The Dynamics of Clusters

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This section addresses two questions. Firstly, it asks how clusters emerge, offering an overview of the circumstances in which various clusters are born and then identifying the ‘facilitating configurations’ that typically enable the birth of clusters. Secondly, it aims to explore what happens once embryonic clusters grow into more developed localised systems of production. The underlying idea is that clusters are characterised by stabilised patterns of interaction that help co-ordinate workers, firms and other organisations in a way that gives them an advantage over non-clustered producers. We explore these patterns with respect to three conditions that earlier sections suggest underpin cluster activity: a specialised labour market, competences and knowledge; capital, investment and entrepreneurship; and inter-firm co-ordination. For each of these conditions, we ask what the underlying patterns are that generate them, and how the patterns are created and develop over time. In the final section we discuss some challenges for clusters, given globalisation and developments in information and communications technology.

### 4.1 How do Clusters Emerge?

As systems of localised economic activity, clusters develop over time. In very general terms, the life cycle of a cluster will be initiated by one or several starting firms which then provide the seedbed for spin-off and imitation (Porter, 1998; Malmberg and Maskell, 2002). This process will usually be sustained through various forms of inertia, ranging from the generation of externalities, the creation of relationships between firms and other organisations to the building of institutions of collective governance. Finally, clusters will usually also go through periods of decline, with death or renewal as ensuing possible scenarios.

The dynamic of clusters over time has been studied in much detail by researchers adopting historiographic methods that focus on the unique features and circumstances of specific cases (Malmberg and Maskell, 2002). Despite its many benefits, one disadvantage of such research is that it is hard to generalise across different cases. However, recent work has contributed much to integrate existing research on clusters, allowing for a consolidation of what we know about the emergence and development of clusters (Keeble and Wilkinson, 2000; Breschi and Malerba, 2001; Bresnahan and Gambardella, 2004; Cooke, 2004; Cumbers and MacKinnon, 2004; Wolfe and Gertler, 2004)

Although much has been written about the regularities underpinning clustered economic activity, the emergence of clusters has been less theorised. Case study research indicates that there is no ‘general law’ as to how clusters are born. In fact, the conditions underpinning the emergence of new clusters are highly varied. Among these are:

- **A lead or anchor firm:** Many clusters develop out of the formation of one or two critical firms that subsequently feed the emergence and growth of numerous smaller ones (Wolfe and Gertler, 2004). An example is provided by Silicon Valley where cluster emergence is often linked to the founding and growth of firms like Hewlett Packard in Silicon Valley or Medtronic in the Minneapolis region (Porter, 1998).
- **Public sector investments and activities:** the existence of public research laboratories has been held responsible for the origin of knowledge-intensive clusters, for example the Strategic Air Command in Omaha, Nebraska, that gave rise to a telemarketing cluster (Porter, 1998). More broadly, the impact of the US National Institutes of Health (NIH) and their laboratories can be seen as responsible for the emergence of the biomedical cluster in the Capitol region (Maryland, US), or the existence of top universities such as MIT and Harvard for the biotechnology sector in the Boston area (Porter, 1998; Powell, *et al.*, 2002; Owen-Smith and Powell, 2004).
- **Shocks and precipitating events:** sometimes specific historic events or circumstances are held responsible for the emergence of clusters. For instance, mass redundancies at a Fiat tractor factory in Modena in the 1950s are said to have given rise to a local economy of small producers in the mechanical sector. Another example is provided by the ICT and biotechnology sectors in the Washington-Baltimore corridor where public sector restructuring and changing outsourcing practices created opportunities for entrepreneurial agents (Feldman, 2001).
- **Local demand and market patterns:** in some cases, local demand plays a role in the emergence of clusters that later obtain an international level of competitiveness. For instance, this includes cases such as the Dutch transport and logistics industry, or the irrigation industry, in Israel (Porter, 1998).

Although such evidence on cluster emergence is provided mainly by case study research we can extract some general lessons. Firstly, it becomes clear from the literature that the factors shaping the emergence of clusters are not the same as those that sustain existing clusters. In an international comparative study of ICT clusters, Bresnahan *et al.* (2004)

argue that the processes of starting and sustaining clusters have different economics. The various types of externalities that typically sustain clusters cannot be held responsible for the initial emergence of clusters. Founding a firm in a nascent cluster – where no relevant externalities prevail – is different from founding a firm in an established cluster where agents operate in a context of facilitating conditions.

Secondly, singular explanations of cluster emergence are difficult to maintain. In fact, successful conditions for cluster emergence could almost invariably be traced back to prior conditions that contributed to creating the precipitating conditions. For instance, the creation and subsequent growth of a lead firm will often be rooted in the existence of favourable conditions underpinned by local labour markets, the existence of research institutions or similar conditions. As Wolfe and Gertler (2004) note, 'in the case of the most celebrated cluster, Silicon Valley, no [such] consensus on its origins exists'.

For this reason it appears preferable to identify facilitating configurations i.e. the specific combination of conditions prevailing at moments when clusters start to emerge. Such a perspective focuses less on historic events and more on the structural environment in which clusters might be born.

In view of existing research, the following factors appear of major relevance:

- **The existence of a specialised labour force** has been identified as a key ingredient of cluster emergence (Wolfe and Gertler, 2004). Both technical and managerial competences are required but not in all cases will the labour force be indigenously created. For instance, there are clusters where the labour force was recruited by means of repatriation (e.g. Israel, India). The situation will be facilitated if the labour pool is under-deployed and hence offers spare capacity.
- **Technological or market opportunity** as the emergence of clusters is driven by the creation and growth of new firms, they will in most cases focus on new or emerging markets rather than build into existing markets (Bresnahan *et al.*, 2004). In particular, this will apply to industries with high barriers to entry, such as ICT or biotechnology, which are characterised by rapidly increasing rates of return. Examples include the semi-conductor industry in Silicon Valley, or the recombinant DNA technologies pioneered by the biotechnology industry.
- **Demand and access to markets:** ready access to customers and market channels is important for rapid growth and specialisation. This may be by standard setting and public procurement. Such demand or access might not necessarily be local and in many cases may rely on external linkages.

Table 1: Facilitating conditions for clusters

Conditions	Examples
Labour force	Higher education Public sector Entrepreneurial activity
Breakthrough technological/market opportunity	Technological breakthrough (biotech, semi-conductor) Consumer behaviour/taste (ski-boots, tiles)
Demand/market access	Global market (semi-conductor) Local demand Supply chain demand (capital goods for local industry) Public-sector procurement (defence)

Summarising then, the emergence of clusters is determined not only by the supply-side factors that are often stressed in the research on existing clusters. Demand-side conditions appear equally relevant. Taken together, this indicates that there will be a higher likelihood for clusters to emerge within contexts where the focal economic activities have a competitive advantage relative to other locations. In other words, for nascent clusters, general competitive advantages will be more relevant than the agglomeration economies typical for existing clusters.

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This has important policy implications. Many cluster policies attempt to emulate conditions in developed clusters, without taking into account that those conditions might not apply to emerging clusters:

*“Conditions that we observe in defined clusters tell us how these systems function and the policy prescriptions that follow from studying these environments may not be appropriate for regions that are trying to develop an entrepreneurial environment... strong local networks, active research universities and abundant venture capital may be attributes of successful entrepreneurship in established clusters” (Feldman, 2001: 862).*

As a result, policies aimed at kick-starting clusters are generally not effective; neither are attempts to pick specific industries or sectors to be sponsored. The implications are detailed in the section on cluster policies below.

#### 4.1.1 Cluster Development and Growth

Once embryonic clusters develop beyond their emerging stage, they become localised production systems sustained by self-reinforcing feedback among entrepreneurs, enterprises, institutions and resources (Feldman, 2001). This feedback produces the productivity and innovation effects that are typical of successful clusters, as described above. In other words, the cluster becomes constituted patterns of interaction between the different stakeholders involved. This stabilisation occurs on several levels:

- **Individual level:** Creation of social networks between individuals involved in companies, intermediaries, support organisations and other involved parties. This process has also been referred to as the creation of social capital (Feldman, 2001).
- **Organisational level:** Relationships among companies and other organisations, for instance via supplier relationships, R&D agreements, distribution agreements etc (Saxenian, 1994). The emphasis on collaboration is compatible with the fact that many firms might also be competing, as for instance in cases where competitors decide to co-operate in specific stages of the value chain such as distribution.
- **Institutional level:** Formation of institutions that enable the cluster actors to engage in collective decision-making to support the production of collective goods and other interventions (Malmberg and Maskell, 2002). For instance, this could be institutions regulating aspects of a local labour market.

These relatively stable patterns of interaction on various levels will shape the competitive advantage of cluster firms but – because of the difficulty to quickly change them – they will also contribute to their decline if general market and technological conditions change.

In the remainder of the section, we will explore how clusters evolve by developing such multi-level patterns. We relate them to specific areas that are important for the functioning and success of clusters: labour, capital, and inter-firm relationships. Importantly, these areas provide the context in which cluster companies operate and compete. Inevitably, companies will always draw on resources and services that come from their external, often local, environment. It is therefore important to explore the patterns that operate in the environment of the firms, providing these resources and services, and in particular, how they are generated and develop over time.

#### 4.1.2 Labour and Skills

Perhaps the single most important driver of cluster development is the existence and ongoing re-production of a specialised localised labour market (Breschi and Malerba, 2001). Clusters tend to be characterised by relatively high degrees of mobility of people across different firms and other organisations, constituting an important source of inter-firm learning ('knowledge spillovers'). Generally speaking, this will cover specialised technical expertise and entrepreneurial-managerial competence.

What are the processes underlying the formation and re-production of such localised labour pools? In the following, we describe some of the mechanisms – bearing in mind that they can operate on the different levels set out above – individual, organisational or institutional – depending on the type of cluster in question.

**Communities of interest and communities of practice:** Clusters such as Silicon Valley are populated by groups of engineers, scientists and professionals who have a strong commitment to their own discipline or professional field. They form formal and informal networks and forums where ideas are exchanged and practices are improved. Such groups have been described as communities of interest or communities of practice. Students of Silicon Valley have described the type of groups that emerged independently from firm affiliation and their achievements in terms of knowledge sharing and innovation (Saxenian, 1994).

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**Formal training and education:** Successful clusters develop mechanisms through which formal learning and training activities are delivered. These will, in general, benefit the broader localised labour pool, even if delivered privately within companies, and can hence be seen as the production of a collective good. In some cases, training provided by some large employers has proven crucial for the wider cluster; witness, for instance, the role of HP or Intel in Silicon Valley (Saxenian, 1994). Alternatives for training supply might be provided via large public sector employers who contract large projects out to local firms; examples are provided by defence procurement in the US, e.g. the area of Northern Virginia (Bresnahan *et al.*, 2001).

In high-tech clusters, higher education institutions also play an important role in the ongoing supply of 'fresh' skilled workers, and their ongoing development through social networks linking people in companies with people at universities. In this respect, the boundaries between formal education and training, and the informal learning via communities of interest tend to be blurred once social networks are at play.

In other cases, more concerted, institutional approaches to training provision exist. An example of this is the mechanical engineering industry in Baden-Württemberg, Germany, where collective arrangements exist, defining common standards and mutual recognition for technical and commercial vocational training (Streeck, 1992; Herrigl, 1996). In the Italian industrial districts, formal training and education plays a relatively minor role compared to 'learning-on-the-job' provided within companies (Becattini and Pyke, 1990).

**Labour mobility:** The collective benefits derived from a specialised labour pool in a cluster are only realised if there is some degree of labour mobility between the firms and other organisations. Such labour mobility can be provided by a variety of different mechanisms. As documented, for the Italian industrial districts, relationships underpinned by kinship or other types of inter-personal commitment, can provide channels through which workers are able to change employers when required. Similarly, as the joke goes, in Silicon Valley workers are said to change jobs more often than their parking lot (Saxenian, 1994). Many of these labour market matches are generated via personal networks that go across firms and sectors and which – depending on the overall institutional context – often overlap with communities of interest, kinship-based allegiances or other groups.

**Labour migration:** It is by no means accurate to say that cluster labour pools are entirely indigenously created. Successful clusters tend to be a magnet for qualified people, both technical and managerial, particularly in high-tech areas. This is true for clusters in high-income economies, such as Silicon Valley, as well as for emerging clusters in countries such as Israel and India (Bangalore) (Bresnahan, 2001, Moore and Davis, 2001).

Concluding, successful clusters develop a variety of mechanisms that ensure the ongoing reproduction, adaptation and renewal of required competence. Depending on the type of products and sectors involved, as well as the national and regional institutional environment, such mechanisms can be constituted on the individual, organisational or institutional levels, or most likely a combination. There is strong evidence, however, that public sector interventions play an important role as far as labour markets are concerned. As Wolfe and Gertler (2004: 1074) conclude:

*"Public interventions that seem to have the most effect in seeding the growth of a cluster are ones that contribute to the development of the asset-base of skilled knowledge workers".*

### 4.1.3 Capital, Investment, Entrepreneurship

Many successful clusters are characterised by high rates of firm founding and growth. This indicates that clusters constitute localised ecologies where 'entrepreneurship events' (Shapiro 1984) are more likely to occur than in un-clustered environments. In this sense, clusters provide a set of conditions that motivate and enable individuals and groups to establish new firms.

Among these conditions, access to investment capital is a crucial and necessary driver of entrepreneurship. There are different ways in which emerging and established firms raise funding, depending on the nature of the industry, and the national institutional context.

Particularly within Anglo-Saxon economies and in technology-intensive sectors, venture capital (VC) tends to enable entrepreneurship in clusters (Florida and Kenney, 1998). Venture capitalists not only provide capital but in many cases also offer management expertise for incubating companies whose founders do not have the required levels of commercial experience and motivation (Carlsson, 2002).

The importance of venture capital is illustrated by studies that show a strong spatial overlap of venture capital firms and high-tech clusters (Powell *et al.*, 2002). This means that in many cluster cases, the venture capital industry is

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embedded in and co-evolves with the local productive system (Feldman, 2001). Informal relationships linking (potential) founders of firms and investors are hence important social channels, and filters, for generating a match between firms and investors. In many cases, a significant amount of capital is even provided by informal venture capitalists, so-called 'business angels' who are well-networked, wealthy individuals with an interest in investing in early-stage ventures (Lockett *et al.*, 2002).

In various clusters, actors have engaged in collective action to provide informal forums for potential entrepreneurs to learn and find investors (Feldman, 2001). In Germany, where the venture capital industry is in its infancy, the state has established public schemes to provide funding to entrepreneurs in specific areas, resulting in the creation of various 'Bioregios' around the country (Casper and Kettler, 2001; Lehrer and Asakawa, 2004).

While the relevance of venture capital has been widely documented, there are some limitations that should be noted. Firstly, VCs do not always have the competence, resources or/and willingness to get involved in firm management. Such a provision of 'real services' (Brusco, 1992) by venture capitalists tends to be confined to the US while UK venture capitalists tend to be less involved with the business given they do not generally have a specialist background (Lockett *et al.*, 2002). It follows that it is not necessarily the existence of venture capital per se that is relevant but the capabilities of the VC industry that will shape their contribution, particularly to early stage company growth.

Secondly, a venture capital community cannot be assumed to pre-date the development of clusters. By contrast, venture capitalists will be attracted to set up local offices by the initial success of cluster development (Feldman, 2001). In many cases, venture capital might even be mediated and provided by previously successful founders who become serial entrepreneurs and fuel the local virtuous circle of investment and growth, for instance in Northern California.

Finally, venture capital is not necessarily a relevant source of capital for all clusters. Notably, in the Italian industrial districts, capital will usually be provided by other means, such as regional banks, via retained profits or social network relationships (Russo and Rossi, 2001). Regardless of the source, however, the ability of would-be entrepreneurs to mobilise capital for the foundation of new firms and the growth of existing ones remains a crucial ingredient of cluster development.

#### **4.1.4 Inter-firm Co-ordination**

The fabric of inter-firm relationships typical for functioning clusters (as opposed to mere agglomerations) generates benefits that neither single, isolated firms nor large, integrated enterprises would have (Malmberg and Maskell, 2002). Firms in clusters often operate in similar markets and might therefore be competitors; at the same time, however, they might co-operate in specific areas to overcome technology or market-related challenges. Benefits include allocative efficiencies (via the relative flexibility of inter-firm relationships), inter-sectoral learning and supply-chain-driven innovation. In this section, we focus on the informal and formal structures that develop within successful clusters to sustain and facilitate such inter-firm relationships on an ongoing basis.

**Supply-chain relationships:** Widespread 'vertical' co-operation has been emphasised as one of the main features of clusters (Malmberg and Maskell, 2002). Research has shown that the creation, maintenance and termination of relationships is often embedded in the fabric of social networks prevalent within clusters. For instance, it is common in high-technology clusters for employees to leave their company and start a new company that supplies their previous employer (Saxenian, 1994). In some cases, vertical co-operation is facilitated by quasi-vertical integration whereby firms are members of a group under the same ownership control, while legally remaining separate entities.

**Horizontal relationships:** Although vertical co-operation tends to be more frequent, clusters also facilitate collaboration between similar firms. Because of their proximity, competitors within clusters know more about their local competitors than firms that are not co-located (Maskell, 2001). Again, such knowledge is often transmitted via untraded interdependencies, e.g. via employee turn-over, existing forums or communities of interest. Social networks therefore play an important part in initiating and enabling horizontal co-operation. But organisation-level factors also play a role. Among the driving forces for horizontal contact and co-operation are opportunities for 'market' consolidation. Such consolidation characterises, for instance, recent developments in the Italian industrial districts where research has shown the increasing importance of 'district groups', i.e. firms linked via ownership (Brioschi, 2002). As for institutional-level drivers of horizontal co-operation, the creation of technical standards in high-tech districts has been noted as an example of mutually beneficial 'co-opetition'. In these cases, various actors work together to institutionalise new technological standards that enable new generations of devices or systems such as mobile phones or PC platforms.

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**Associations and consortia:** Within some contexts and product categories, firms in clusters have created umbrella organisations that operate in the collective interest of the members although as individual firms they might be close competitors. In the Parma region in Italy, local producers have created powerful brands by creating umbrella organisations that pool resources and provide centralised marketing and distribution services. Export syndicates were created in some Italian districts to promote the distribution of goods abroad (Baldoni *et al.*, 1995). In high-tech regions, organisations often co-operate to influence regional public policy and improve the attractiveness of places to do business via regional marketing; an example is provided by the Massachusetts Biotechnology Council.

**Support services:** Apart from their core firms specialising in the production of specific products or services, many clusters have generated from within or attracted from outside a population of firms that provide non-core services and support. For instance, in science-based clusters, service providers will provide expert support on issues of intellectual property rights and technology transfer. The availability of such services is a distinct advantage particularly for small firms that do not have the critical mass and competence to conduct these services internally. Support services also play an important role in inter-firm learning and diffusion of practices and will serve a number of clients simultaneously and over time. As with other environmental conditions discussed so far, there are different ways in which support services emerge and develop. In many cases, this will be market-driven but in others cluster actors engage in collective action to cater to their needs, often in conjunction with regional public sector agencies or chambers (Brusco, 1992). A market-driven example are the 'Beltway Bandits', a population of consulting firms around the Pentagon (Ceruzzi, 2000). An example for a public-sector-supported scheme is provided by the CITER organisation in the Emilia Romagna region that provides advice and support services to local textile firms (Cooke, 1996).

## 4.2 Challenges to Clusters

The future prospects for clusters must be considered in the light of a number of key changes in the nature and context of economic activity – increasingly global value chains and markets, increasing diffusion and availability of information and communication channels across virtual networks. These significantly impact and transform processes of knowledge creation in at least two ways:

- Learning increasingly takes a virtual, non-spatial dimension. Global and virtual innovation networks, such as the self-organising Open Source Communities (Raymond, 1999), constitute an extreme but relevant case of communities bound only by the tenuous strand of the Internet that compete with more traditional place-based organisations and networks.
- There has been a radical increase in the diversity and distribution of competences and disciplines needed for product and process innovation. Single localities or single firms (even in the extreme cases of Silicon Valley or IBM) cannot master the entire range of required capabilities and are therefore forced to open up knowledge creation processes and share intellectual property rights.

These changes therefore redefine the extent and nature of social and economic networks. The long-term sustainability of industrial clusters as self-contained closed systems – open only at the beginning and end of the value chain for raw material and sales (Corò and Grandinetti, 1999) – is in question. The fundamental features of localised learning, endogenous dynamics (or growth), with the complete supply chain within the geographic boundary of the cluster (Porter, 2000) are confronted with new challenges. Globalisation and the ICT revolution are changing the features of clusters in two ways: a) proximity becomes a fluid mix of geographic and organisational proximity and b) the self-contained model is fragmenting with a mix of local and virtual chains, where supply chains, learning and innovation dynamics are redefined and geographically spread. The example of how the Montebelluna cluster has evolved and expanded its reach to take advantage of the changes in the global environment demonstrates the point (see case study 2 p23).

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### **Case study 2: The Case of Montebelluna**

Montebelluna, known as the “snow capital” (Newsweek, February 1979), is a small town in the North-East of Italy near the Dolomites. A core of 400 firms employs about 8000 local workers, with 60,000 additional workers employed in the external belt of subcontracting activities, decentralised mainly in Eastern Europe (Belussi and Pilotti, 2002). The numbers are impressive: 80% of motorcycle shoes produced in the world, 75% of all ski boots, 65% of after-ski boots, 50% of technical mountain shoes, and 25% of in-line skates (Osem, 2001) are manufactured in Montebelluna or in areas under its influence. Montebelluna has evolved from a Marshallian district, where production is finely divided across a local set of extremely specialised firms. It is now a technological cluster, that is, an area with an extraordinary concentration of international firms with dynamic capabilities around innovation and production. Since the late 1970s, many leading international firms (Cabelas, Decathlon, Intersport (McKinley), LL Bean, Eindl, Mephisto, Merrl, Raiche, Rockport (Reebok), Timberland, Fila, Ambro, Mizuno, Asics, Mitre, Umbro, Vasque, Rossignol) have located R&D departments or started partnerships/collaboration programmes with local firms in the area (Belussi and Asheim, 2003). In this sense, Montebelluna can be considered an example of a localised cluster that is simultaneously integrated into a wider international value chain of activities.

There are a number of lessons that may be taken from the case. Firstly, the need to access information and to take advantage of a global division of production does not imply the end of the cluster form. On the contrary, clusters evolve towards a more open form where an eco-system of local and external companies interact around product and process innovation. Secondly, contrary to some expectations, the case of Montebelluna (and Silicon Valley), shows that the presence of multinational corporations is not necessarily detrimental to the cluster form. Thirdly, in the case of Montebelluna a curious outcome of globalisation and firm mobility is worth noting: multinational firms locate part of their innovation-related activities close to existing innovation and production clusters and are willing to engage in partnership and subcontracting relationships with local companies. This is called “diffused globalisation” (Grandinetti and Rullani, 1992). The cluster expands via the absorption or co-optation of externally located firms, which remain based elsewhere and interact on specific aspects (design, technical capabilities, R&D) with local firms. This is a two-way process. External companies bring a different mindset and managerial approach to the cluster. The success of the interaction between local and multinational firms requires the bridging of different cultures and represents a challenge for local systems of production and innovation.

The tendency of Montebelluna firms to outsource their production activities to Eastern Europe to exploit the cost differential suggests that successful clusters can survive by expanding and shifting specific value chain activities to other countries. The globalisation of production means the end of the self-contained cluster model rather than the end of clustering per se. Clusters evolve from geographic self-sufficient agglomerations to a multi-centric network with different degrees of closeness to the central place and business core.



# 5 The Influence of Public Policy on Cluster Development

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## 5.1 Does Cluster Policy Matter?

The prevalence of cluster-related policies in DTI, RDA and local authority strategic planning documents illustrates two points. Firstly, that clusters are considered to have beneficial effects on competitiveness (at whichever spatial scale) and secondly, that the public sector can have a beneficial influence on their development or performance.

Preceding sections have proposed a number of ways in which clusters might have competitive benefits for firms involved, and potentially for regions, although the impact of clustering activity on innovation and/or productivity, and thus competitiveness, are far from straightforward in practice.

Even less clear is the way in which policy tools are thought to impact upon cluster prospects. This is in general due to a relative lack of constructive debate in the literature, and specifically in the UK, due to the delegation by the DTI of 'day-to-day' cluster management to Regional Development Agencies, which somewhat separates the formulation of policy tools from the intellectual process that has identified a cluster strategy as important for the UK competitiveness agenda. Thus, those public servants entrusted with managing and encouraging cluster behaviour are doing so not necessarily because they have seen a strong tendency towards clustering in a particular activity in their locality. Rather, different types of local economic activity are subsumed under the cluster concept although clustering might not actually take place. This 'shoehorning' of regional activity and subsequent policy interventions into the complex (and sometimes poorly understood) cluster concept risks encouraging inappropriate policy actions.

## 5.2 What Cluster Policy Cannot Do

It is clear from a reading of the literature that even cluster proponents see very well defined limits to the ability of public agencies to influence their creation and development. Michael Porter as well as the DTI are clear on the inability of the public sector to create clusters from 'scratch'. For example, the DTI cluster website<sup>1</sup> says:

*"[the DTI] ...encourages Regional Development Agencies (RDAs) to develop existing and embryonic clusters in their region, building on their natural regional capabilities..."*

Implicit here is an acceptance that government, firstly, cannot create clusters and secondly, can only enable sustained cluster development when local economic conditions already favour that cluster. Further, in placing cluster-strategies firmly within the national-regional competitiveness agenda, there is perhaps a further and stronger implication that is common throughout the cluster literature: that 'successful' cluster development is in part dependent upon 'natural' regional capabilities conferring a relative comparative (or competitive) advantage compared to other regions or locations which might support incipient clusters in the same activities.

However, there is no guidance available from DTI on the practical identification of whether a region possesses such advantages. For example, the identification by Lord Sainsbury (2002) and others of the importance of higher education institutions in biotech cluster development has appeared to encourage a relatively low bar to be set for the identification of potential clusters. Medical technology has been identified as an 'aspirational' cluster for the West Midlands following a scoping study which identified the existence of strong medical schools at Birmingham and elsewhere, including the East Midlands. The report provides a detailed rendering of where the West Midlands might have competitive advantage within the sector. It identifies Yorkshire and Humberside, Baden Württemberg as comparator regions which have an existing biotech advantage. The report identifies ten factors which encourage cluster development. The West Midlands is reported as 'weak' on nine of these criteria and 'medium' on the other. Meanwhile there is only a single instance of any of the comparator regions being considered 'weak' on any of the criteria. Yet, the report concludes that the cluster has potential in the West Midlands, implying that the cluster has been identified by policymakers with little or no reference to international or even UK comparative advantage<sup>2</sup>. This approach is not untypical of many identified clusters in the UK.

A cluster concept which stresses the importance of agglomeration economies, innovation and sustained social networks (however ranked) also has implications for the type of socio-economic contexts where cluster policies might be appropriate or inappropriate, in the short and medium term at least. The malleability of the term has led to suggestions that clustering offers hope for post-industrial areas in decline, for the rural economy and for inner-city areas where social exclusion, disaffection and labour market disassociation are common. However, not all such systems and localities automatically qualify as cluster-friendly. Notably, the cluster notion implies both the existence and distribution of both economic and social capital amongst actual or supposed cluster members. Moreover, there would also appear

<sup>1</sup> <http://www.dti.gov.uk/clusters/policy.htm>

<sup>2</sup> <http://www.advantagewm.co.uk/technology-cluster-mapping-report-238-977-k.pdf>

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to be a minimum level of complexity (and hence minimum number of involved actors) before a system of production or innovation could be considered a cluster. Lack of such attributes and such 'critical mass' may be major problems for poorer and dispersed areas, and the proposal that clustering can help here is therefore problematic, and needs distinct and theoretically sound discussion (McGregor, 1999).

Finally, the emphasis of cluster theory on innovation, knowledge development and complex relationships is likely to create tensions with any economic policy which has employment generation as a prime motivator. Only if the posited causal links between clustering, firm performance and regional competitiveness actually exist will clustering then indirectly impact upon the prospects of the un- or under-employed elsewhere in the clustering region. Moreover, it is difficult to see such linkages impacting upon regional prospects in anything under a decade. Meanwhile, direct impacts in terms of significant employment generation might be restricted to those circumstances where a large firm or plant leverages location economies through its supply chain or dedicated labour market and thus not appropriately considered 'cluster' policies per se.

### **5.3 What Cluster Policy *Might* Do**

The above factors limit the room for public policy manoeuvre, as does the apparent inability of any observer to predict future cluster development. However, that is not to say that the public sector can have no impact. Firstly, there may be a set of economic circumstances and structures which enhance the likelihood of clusters forming. Secondly, embryonic clusters may require outside encouragement to develop clustering behaviour, particularly if outside parties can deduce potential long term benefits or synergies which, through information asymmetries or strategic competences, are not obvious to the potential members. Thirdly, during development, clusters might encounter specific bottlenecks or brakes on development which hinder further growth and which cannot be solved without outside aid.

Earlier sections have hinted at how cluster development may be optimised, and the importance of cluster dynamics. Considering clusters and clustering activity under the three developmental stages above illustrates how public policy might positively influence that development.

**A Positive Context for Cluster Development** – The literature suggests that fundamental socio-economic and related structures within a region or nation can enhance the likelihood of clustering behaviour. This may be directly relevant, as in patenting and intellectual property (IP) laws which recognise and encourage joint ownership and benefits, or in ease of (low cost) access to legal and procedural advice regarding joint ventures. More indirectly, it may be that in the same way as Richard Florida (2002) has suggested a creative and tolerant population is more economically beneficial, a population which is endowed with the ability to accumulate knowledge in varied circumstances, where entrepreneurship is respected and in which the development of a wide range of high-value social contacts is the norm might be more 'cluster friendly'. Hence, a number of current non-cluster development policies, including the encouragement of entrepreneurship and an increased focus on education and lifelong-learning may provide an economic context within which clusters are more likely to develop.

**Encouragement of 'Embryonic' Clusters** – Nascent clusters may face internal or external barriers to their development into 'full' clusters which constitute a degree of market failure. For example, there may be a lack of a suitable context (or physical facilities, including incubator-type premises) which allows potential cluster members to meet and discuss suitable joint developments, innovation or input into public policy. There may be information gaps and asymmetries which hinder long term efficiency, either in potential cluster members under-estimating the benefit of joint working or, more fundamentally, being unaware of other businesses in the locality undertaking potentially complementary activities. These varied capacity constraints may provide a rationale for short-term intervention if the appropriate mechanisms and of course embryonic clusters themselves can be properly and defensibly identified. The Subsea Technology Cluster case illustrates some points about the development of embryonic clusters and the role that cluster policy might play in their development (see case study 3 p30).

**Intervention to Enhance/Protect Cluster Development** – Submissions to the Management Research Forum and more general research emphasise that clusters often exist in a dynamic and challenging environment. Indeed, often the very development of a cluster is a response to a development challenge or bottleneck. However, it may also be true that the public sector can provide a useful service to clusters in critical or stymied situations, for example through the provision of suitable physical, ICT or training infrastructure, or through providing a mechanism whereby the products of cluster activity (e.g. intellectual property) can be centrally and beneficially held.

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The above typology of potential public sector influence emphasises the importance of the dynamic element of cluster development, and the need to reflect this in public policy making. By emphasising the influence of public policy at specific stages of cluster development, it also implies that ongoing public support or subsidy for cluster activity is likely to be inefficient – and indeed, should clustering confer productivity and competitive advantage on the firms themselves, completely unnecessary.

## 5.4 When Should the Public Sector Intervene through Cluster Policy?

The preceding sections of this report have highlighted the multi-faceted and complex nature of clusters. It has reinforced the notion that clusters represent a co-existence of those hard economic efficiencies that are only available to organisations which are co-located, together with innovative and competitive benefits that arise from the development of non-traded dependencies and enduring and high-value relationships.

The above has key implications for the implementation of any cluster policy. If cluster policy does not arise from a considered and coherent intellectual position, it will fail. Moreover, the case study evidence suggests that successful cluster development does not depend on the involvement of public sector organisations in the majority of cases.

Thus, the fundamental prerequisite for public interventions should remain the existence of identifiable (or strongly hypothesised) market failure. For example, it was argued that the development of the UK Motorsport cluster might be hindered by poor access to Silverstone race circuit. Here, ameliorative infrastructure development might reasonably be considered the province of public agencies, whereas the case for public investment in the facility itself is much more problematic.

As the DTI makes clear, a cluster policy is only appropriate for RDAs when distinct regional capacity or endowment advantage can be discerned in that activity. However, there is more left unsaid regarding the practical implementation of cluster policy.

## 5.5 What is the Conceptual and Practical Model?

UK cluster policy must recognise the complexities and wide range of the cluster concept. This does not mean that each cluster policy or instrument must be complex and wide-ranging; rather that a flexible suite of policy tools is available to meet different situations. However, the development of this suite of tools must reflect the conceptual model of clusters as systems that both lever traditional agglomeration economies and competitive advantage through non-traded and social links and shared innovation. Additional to the above, might be specified some possible characteristics of ‘good’ and appropriate cluster policy.

**An activity/product concept** – All cluster definitions emphasise their spread amongst related but distinct industries. Cluster identification and any consequent policy intervention cannot be based on a narrow industry concept or classification. More appropriate is a consideration of what activities are undertaken within a local productive system in the creation of products, commodities or services. In summary, cluster policy is not sector policy.

**A long time frame and ‘evolutionary’ approach** – Cluster development takes time. Complex processes and high-value inter-relationships between companies and people cannot be created overnight. Even after a cluster has developed, the mechanisms by which its success might then benefit regional competitiveness are somewhat hazy but certainly unlikely to be sudden. Expecting to see the results of cluster policy within a short number of years is unrealistic. Policies should also reflect the fact that clusters change over time, and that intervention should be targeted according to the cycle of cluster development, and with limited goals which preclude long term resource support.

**Restricted to appropriate circumstances** – Where there is an appropriate level of social and economic capital, suitably distributed, and a critical mass of potential participants, to make clustering activities sustainable. Thus the adoption of ‘clusters’ as a mechanism for rural or inner city regeneration in particular is problematic.

**A consistent approach over time and space** – As this report has demonstrated, the cluster concept is complex and differently interpreted. Economic agencies in the UK have, over a relatively short space of time, tended to stress different facets of economic activity as key to development prospects – including productivity, the ‘competitiveness agenda’, sector-specific aspects and clusters themselves. There is often only a cursory attempt to explain the causal links between these aspects. If the language and emphasis of DTI and other agencies continues to shift (and shift differentially) over time and space, there is unlikely to be widespread ‘buy in’ to the cluster agenda.

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**Coherent evaluation tools and mechanisms** – If clusters are about leveraging competitiveness and success through shared resource, knowledge transfer and increased innovation, then their success cannot be measured using blunt instruments such as employment outcomes and levels of value added. It will be incumbent upon the public sector to develop appropriate evaluative tools for cluster policy, even if these tools are likely to be more process-oriented and qualitative than those currently in place.

## 5.6 Responsibilities and Co-ordination in the Institutional Structure

The current institutional framework for economic development in the UK (in England, in particular), whether by design or otherwise, emphasises competition between regions for inward investment and in the development of key sectors and clusters. The DTI provides the broad conceptual framework, and also an emphasis on productivity and competitiveness – and the quantitative tools to imperfectly measure these factors. Meanwhile, implementation and the development of specific policy tools is usually the responsibility of RDAs.

This structure may be inappropriate. For example, the cluster hypothesis stresses the importance of shared innovation and high-value relationships – yet between RDAs competitive behaviours are far more evident than cooperative ones. There may be both a credibility gap and actual efficiency losses in this approach. For example, the UK has a developed cluster in motorsport engineering in the East Midlands that is strongly supported by central government and the East Midlands Development Agency. Meanwhile, the Wales Motorsport Initiative seeks to develop an engineering education infrastructure and to encourage knowledge transfer between SMEs, based in part around the Wales Rally GB (Welsh Development Agency, 2005). However, whilst there is a desire at national government level to link motorsport with other clusters, such as aerospace (Sainsbury, 2002), there is little or no appreciation that there may be links and synergies between Wales and the East Midlands, despite the complementary nature of much activity. This is at least in part due to the competitive friction between the two regions.

It is in general difficult to reconcile the DTI emphasis on the need to identify embryonic clusters and ‘regional capacity’ with the astonishing overlap in the cluster policies of UK RDAs. Over half of UK regions claim potential clusters or ‘key sectors’ in ICT and software; creative industries and media; bio-technology, food and drink; and automotives (see table 2). There appears to be no evaluation, monitoring or ‘reality check’ of those clusters and activities identified by English RDAs in their Regional Economic Strategies. It stretches credibility to believe that the UK could be home to half a dozen or more globally successful biotech clusters. Thus most strategies (if not all) will fail, raising the question of whether this constitutes an appropriate direction of public funds.

An abandonment or softening of the current model of ‘competitive regionalism’ requires the central agency to become more involved in the overall moderation and co-ordination of regional cluster policies, in addition to current efforts concentrating on outlining general policies and providing research intelligence. This would help avoid a repetition of the duplication of effort, ‘zero sum games’ and consequent inefficient use of public funds that characterised regional efforts to attract mobile capital in the 1980s and 1990s. Currently there seems little or no central effort to synthesise efforts to develop UK clusters that aim to be globally competitive.

The subsea cluster case illustrates how a nationally co-ordinated cluster policy can enhance cluster prospects (see case study 3). In this case, a national initiative under the DTI called “Subsea UK”, plays a supra-regional role and helps coordinate the actions of various local clusters. It represents the cluster nationally and internationally and constitutes a group to advance the interest of the subsea companies with the central government. Regionally confined clusters are usually unable to engage in such activities and risk missing opportunities afforded by national level programmes.

This case illustrates that there is scope for nationally co-ordinated cluster policies that rely on a synergetic combination of capabilities spread across different local clusters.

Table 2: Regional Development Agencies – Priority Sectors & Clusters

<b>RDA</b>	<b>Sectors identified</b>
<b>Scottish Enterprise DA</b> <a href="http://www.scottish-enterprise.com">www.scottish-enterprise.com</a>	biotechnology, food, oil and gas, opto-electronics, semiconductors, software including multimedia, tourism
<b>Invest Northern Ireland</b> <a href="http://www.investni.com">www.investni.com</a>	contact centres, hi-tech manufacturing, life & health sciences, software, telecoms/ electronics
<b>East of England DA</b> <a href="http://www.eeda.org.uk">www.eeda.org.uk</a>	key sectors: selected against a range of criteria including size, growth prospects, r&d base, markets and multiplier effects. ICT , life sciences, media and cultural industries, financial and business services, agriculture and food processing, tourism leisure and heritage, automotive, high-technology manufacture and advanced engineering, transport gateways
<b>South West of England RDA</b> <a href="http://www.southwestrda.org.uk">www.southwestrda.org.uk</a>	aerospace, biotechnology, creative industries, environmental technologies, food and drink, ict, marine, tourism
<b>One NorthEast</b> <a href="http://www.onenortheast.co.uk">www.onenortheast.co.uk</a>	Seeking to develop and support a strong portfolio of clusters in: automotive & precision engineering, bio-science, chemicals, clothing & textiles, culture, digital/ multimedia, electronics, environmental industries & energy, food & drink, nanotechnology, offshore/ marine engineering tourism
<b>South East England DA</b> <a href="http://www.seeda.co.uk">www.seeda.co.uk</a>	sector groups have been established: defence and aerospace, media and creative industries, transport and logistics
<b>Advantage West Midlands</b> <a href="http://www.advantagewm.co.uk">www.advantagewm.co.uk</a>	added value engineering, automotive, electronics & telecommunications, food & drink, healthcare & pharmaceuticals, logistics & e-fulfilment, rubber & plastics' services & e-business, software
<b>Yorkshire Forward</b> <a href="http://www.yorkshire-forward.com">www.yorkshire-forward.com</a>	advanced engineering, bioscience, chemicals, digital industries, food & drink
<b>North West DA</b> <a href="http://www.nwda.co.uk">www.nwda.co.uk</a>	automotive components, financial services, food & drink, ICT, life sciences (pharmaceutical, biochemical centres), software
<b>East Midlands DA</b> <a href="http://www.emda.org.uk">www.emda.org.uk</a>	existing/emerging clusters area seen to have a competitive advantage in & where there is potential for growth: clothing & textiles, creative industries, food & drink (processing & technology), healthcare industries, high performance engineering
<b>London DA</b> <a href="http://www.lida.gov.uk">www.lida.gov.uk</a>	setting up business-led advisory "sector commissions" in: creative industries, manufacturing

Source: WDA (2002)

### **Case study 3: The Subsea Technology Cluster (STC) in the North East of England**

Research conducted at Durham Business School shows the difficulty of recognising existing geographic clusters that emerge from the ashes of once dominant sectors and suggests ways in which policy-making can intervene at the national and regional level.

The subsea sector is relatively new and its roots go back to the 1960s when the exploration of North Sea oil and gas started. Tapping into the natural resources in these severe conditions required new, often bespoke, technologies and skills, as well as relevant infrastructure for those technologies to be developed. The cluster developed and built its success on a unique set of (predominantly) technological capabilities, serving a wide range of markets, of which the dominant one was and still is oil and gas. Many of the North East firms are recognised as world leaders in their field.

The STC in the North East consists of around 100 companies, with a range of employment from 1 to over 1500 employees. In the context of the subsea sector in the UK, the STC specialises in subsea manufacturing (so continuing a secular tradition of excellence in manufacturing) and takes a significant fraction (approx. 15-20%) of the national subsea sector revenues (estimated at £5 billion/year).

Our research shows that the emergence of the STC was related to the presence of a set of enabling conditions and the occurrence of three main sets of events.

#### **Enabling conditions:**

- (a) the existence of a heavy engineering tradition (shipbuilding, heavy civil construction and engineering), related infrastructures and facilities, and availability of a wide-ranging base of skills and technical capabilities constituted the platform for STC;
- (b) the presence of research centres (British Steel, British Gas) and Universities provided a necessary scientific base for STC;
- (c) the crisis of mining and shipbuilding liberated previously locked-in skills and generated a pressure to diversify;
- (d) the development of the North Sea fields was the key driver of the subsea expansion.

#### **The events:**

- Northern Ocean Services developed some of the crucial technologies in close collaboration with SMD (Soil Machine Dynamics, see below) and managed to attract, in concerted action with Tyneside and Teesside Development Corporations (later to be replaced by the regional development agencies), the two leading companies in the area (Wellstream and Duco).
- Research carried out by the Department of Agriculture (University of Newcastle) provided some crucial technological know-how. A professor at the department realised that the technologies needed to install submarine cables in part already existed in his agricultural department. The process was adaptive rather than radical. Consequently he left Newcastle University and founded Soil Machine Dynamics. SMD is now world leader in its sector.
- The closure in 1994 of a British Gas research centre specialising in corrosion generated a major entrepreneurial wave in Newcastle. The researchers, who didn't want to leave the region, turned themselves into consultants or launched approx. 10 highly specialised subcontractor firms. The firms' expertise reproduced the pattern of specialisation within British Gas and were hence largely complementary and highly cooperative. Over time, they formed a micro-cluster, Pegasus, responsible for the marketing, PR and coordination of the group of firms. This group has also shown the way regarding the cooperation between academic science and industry by launching the first Master of Science (MSc) in pipeline engineering in partnership with the University of Newcastle. The MSc is a way to integrate the necessary on-the-job training with the set of technological and scientific competences needed in the STC.

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### **The Subsea Technology Cluster (STC) in the North East of England (cont.)**

#### **What can we learn from this case?**

- *Although the origins of STC are related to the actions of Tyne & Wear and Teesside Development Corporations back in the '80s, the development of STC took place autonomously from any regional policy or other public initiatives, which, at the time, were looking to stop and/or reverse the decline in the traditional employment sector of the North East.*
- *The STC highlights a major problem regarding the identification of embryonic clusters. Embryonic clusters usually originate from within existing sector(s), but pale to insignificance when compared with the incumbent sector(s). They tend to survive in the shadow of the sector(s) they descend from, and consequently struggle to acquire a shared identity and a clear profile. This happens only with time and when some major event shakes the affiliation links with the previous sector(s). As a consequence and up to now, the STC is not recognised and doesn't appear in any classification of industrial clusters in the North East.*
- *The role of serendipitous events cannot be overstated. The fact that an agricultural department would lead technological development in the subsea sector stretches any amount of imagination. Although retrospectively the connection is clear, ex ante, it is exceedingly difficult to spot. The message for policy is that highly interventionist policies would hinder the development of an environment that facilitates the occurrence of serendipitous events.*
- *The development of clusters is rarely linear. In our case we have identified some enabling conditions, which were far from being necessary and/or sufficient. Several events concurred to form the STC but we doubt that any amount of policy would have been able to plan its development.*

#### **What cluster policy might do for the STC**

- *Encourage the formation of a shared identity by providing forum for knowledge exchange and privileged channels for cluster representation (for instance at trade fairs).*
- *Raise the profile of STC inside and outside the region by 'selling' it as a success story.*
- *Encourage the interaction and integration of the NE cluster with national and international initiatives in the subsea sector.*
- *Work in conjunction with firms, support institutions and universities to address the dramatic shortage of skills and competences.*
- *Provide necessary infrastructures that single firms cannot develop on their own (for instance, testing centres for deep water technologies). The testing centres can also act to promote shared innovation and a culture of collaboration.*



## 6 Research Recommendations

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Given the central importance of, and interest in, clusters there are questions that remain to be answered. These include:

- How can embryonic clusters be identified? Almost by definition, embryonic clusters are so small they that defy econometric-based analysis techniques, whereas qualitative methods are too labour-intensive, expensive and difficult to generalise across different areas and sectors. What type of methods can provide reliable and timely results about the emergence of embryonic clusters?
- How do clusters emerge and particularly does the presence of human capital facilitate the development of clusters or does the presence of a cluster facilitate the development of human capital? Clearly the answer to this question has important implications for the agenda associated with skills and mobility of labour.
- To what extent do clusters spawn other clusters? If regions are successfully able to nurture clusters then can they develop a regional competence that enables them to nurture new clusters and do they capture the economic benefits that result?
- This report suggests that established and embryonic clusters constitute two very different classes of clusters. One implication is that policy should differentiate between these two classes of cluster, but what policy instruments best suit these?
- As clusters grow what is the impact on economic distribution and social welfare? If clusters require a critical mass of firms, access to an appropriate labour pool, well-developed infrastructure, then is it possible for clusters to emerge in economically deprived areas? Or do clusters encourage the process of concentration of wealth in economically developed areas?
- What is the impact of cluster diversity on innovation? Does diversity within a cluster facilitate or hinder innovation and where are the boundaries?
- An emerging theme in the literature is the network society. This has generated a tension between activities and processes that are best dealt with in a spatial context and those that thrive in a virtual space. Developing a virtual infrastructure in order to reduce information search cost or to exploit economies of scale, say in procurement or supply chain management, could be a goal for policy-making. However, the experience so far with portals, electronic knowledge spaces is largely negative. It is unclear what type of infrastructure is needed and perhaps more importantly how to induce small companies to make use of it. Further research could help shed light on the value of such virtual infrastructure for companies and whether they can replace proximity-based interactions.

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# Notes

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*ISBN No: 0-9546885-7-0*

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*The Advanced Institute of Management Research  
is an initiative supported by ESRC and EPSRC*