1 Introduction
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This handbook presents a comprehensive overview of research on economic clusters, which will be of interest to scholars doing research on clusters and clustering as well practitioners involved in cluster formation and cluster management. In the development of this book, leading writers on clusters from many countries have been attracted. The result is a thorough overview of clustering in high-tech industries, cluster case studies, and cluster policies presented in this handbook. A parallel overview of economic cluster research in terms of agglomeration and cluster theory, methods for analysing clusters, clustering in different spatial contexts, and clustering in service industries is presented in a parallel handbook, the *Handbook of Research on Cluster Theory*, edited by Charlie Karlsson and published by Edward Elgar. The studies cover the developed economies in Europe and North America.

1.1 High-tech clusters

A huge interest has in recent decades been devoted to the phenomena of high-tech clusters among scientists, politicians and planners, as well as in media. These clusters that also are described as innovative, knowledge-intensive and the rest contain one or several industries that are R&D-intensive, have a high share of university trained employees and so on. In this section, we comment upon two aspects of high-tech clustering. Firstly, we discuss the general conditions that seem favourable for high-tech clustering to take place. Secondly, we discuss some of the process involved in high-tech clustering.

Clustering is a localized phenomenon mainly taking place within the borders of functional urban regions. A functional (urban) region is characterized by its agglomeration of activities and by its intraregional transport infrastructure, facilitating a large mobility of people, products and inputs within its interaction borders. The basic characteristic of a functional region is the integrated labour market, in which intraregional commuting as well as intraregional job search and search for labour is much more intensive than the interregional counterparts are (Johansson, 1998). The border of a labour market region is a good approximation of the borders of a functional region. The idea of the functional region has a place in most models of urban economies. In New Urban Economics, for example, an urban region is identified by deriving increasing commuting costs from increasing distance to the city centre, which hosts the majority of all work places (Fujita, 1989).

We will not here contemplate the birth or initiation of high-tech clusters. It is well known that high-tech clusters can be initiated by a variety of incidents stretching from pure historical developments to conscious public planning. The variety is so wide that it is questionable whether it is possible to draw any general conclusions about the initiating factors. However, we believe that the growth of high-tech clusters, once they have been initiated, can be understood as a dynamic interplay between many different processes.

1.1.1   *Demand and supply factors and high-tech clustering*

When explaining the clustering of firms, it is natural to make a theoretical distinction between forces working at the demand side (implying that clusters offer a large enough demand for distance-sensitive high-tech products) and those working at the supply side (implying that clusters offer better conditions for innovative activities). Of course, it might be difficult to distinguish the relative importance of the two types of forces empirically, but a distinction between supply and demand creates some order in the discussion.

Even if most studies of high-tech clustering seem to have concentrated on supply-side phenomena, it might be worthwhile also paying some interest to demand-side factors. It seems clear that there is a strong tendency among high-tech clusters to be located primarily in those large urban regions[1] in rich industrialized countries that can be characterized as metropolitan regions. These regions offer good conditions for innovative firms developing new products, since they offer a large extremely local home market but also a good accessibility to the markets in other large urban regions in the home country as well as abroad, thanks to well developed air traffic networks.

Large urban regions in developed countries normally are concentrations of company headquarters, company R&D divisions, other advanced industries, research universities, university hospitals, R&D institutes and high-income earners; they are concentrations of demanding customers with a strong willingness to pay for innovative products meeting their specific requirements. Thus, owing to their demand structure, these regions are excellent testing grounds for new products. Because of their high internal accessibility, they also offer good opportunities for extended periods of interaction with customers during the product development and testing phases. In other words, these regions offer a home market where new innovative products can be tested and nurtured before, in the first phase of production, they are exported to other large urban regions and, in the second phase, more generally.

There are general incentives for entrepreneurs to locate their firms in large urban regions because they are more likely to be better exposed to customers there. Searching is costly for customers who, *ceteris paribus*, will prefer to minimize search costs by purchasing in areas of concentrated supply. This is particularly relevant in markets with discerning potential customers with specific requirements, searching for high quality, and high performance before purchasing (Karlsson and Johansson, 2006).

A further advantage of locating in large urban regions is the positive information externality in such regions, through which individual entrepreneurs and firms receive signals about the strength and content of regional demand by observing established suppliers' successful trades. Such observations also inform about varieties of existing products, including lack of varieties, and can of course trigger the development of new varieties. Moreover, the fact that a given firm is located in a large urban region with a successful high-tech cluster provides potential customers with an indication or image of quality.

Like all other entrepreneurs, high-tech entrepreneurs can reduce their risks by locating in large urban regions (Mills and Hamilton, 1984). To the extent that fluctuations in demand are imperfectly correlated across customers, the demand for products with high geographical transaction costs can be stabilized in a large urban region since some customers are buying, while others are not.

The concentration of purchasing power and demanding customers in large urban regions is a stimulus to entrepreneurs to start imitating successful products and thereby

often also improving them in order to take market shares from incumbents by being localized near them: within the same region (Hotelling, 1929). Indeed, when the competition in the product market is imperfect, which is the case in high-technology markets generating a large number of products varieties that are imperfect substitutes, geographical proximity increases competition in the product market (Fujita, Krugman and Venables, 1999). The gain of such actions may be short-lived if further high-tech entrepreneurs enter, or if the incumbents in the region react to this unwanted competition. However, this kind of competition is critical in keeping a high-tech cluster vital and vibrant, even if many high-tech firms over time may suffer from proximity to other firms and may eventually lead them to fail.

On the supply side, large urban regions offer high-tech entrepreneurs and firms advantages in terms of accessibility to a large pool of well-educated and specialized labour (Marshall, 1920), particularly, specialized workers in different technical fields, but also in accounting, law, design and advertising. This reduces the costs for starting and expanding new businesses (Krugman, 1993). Furthermore, densely populated agglomerations are conducive to a greater provision of non-traded inputs, that is, their producer service infrastructure is more developed. Such inputs are provided both in greater variety and at lower costs in large urban regions (Krugman, 1991a, 1991b). There also exist physical infrastructure benefits for high-tech entrepreneurs and firms to locate in large urban regions, in terms of access to highways and airports, and thus better accessibility to suppliers located in other regions or abroad.

However, more important is probably that the large urban regions offer a concentration of and accessibility to R&D in companies, R&D institutes, and research universities, and so on, as well as various arenas for knowledge diffusion and knowledge exchange. They also offer a high accessibility to knowledge generated in other large regions by means of air travel, the Internet and intra-company networks in large multinational firms, which implies that they are well positioned to follow the knowledge developments in other large urban regions. Thus, large urban regions offer advantages to high-tech entrepreneurs and firms in terms of a large potential to take advantage of various knowledge flows, which is particularly important when the knowledge is complex and perhaps tacit in nature (Jaffe, Trajtenberg and Henderson, 1993). Generally, a form of informational externality accrues to new high-tech entrepreneurs from observing established firms that produce successfully in large functional regions: there are large potentials for production knowledge to spill over in large, dense regions. Thus, the start-up of any high-tech sector should increase with the existing density of firms in each sector. A final reason for advantages of large urban regions for high-tech entrepreneurs arises from reductions in transaction costs (Quigley, 1998). In particular, search costs for customers, suppliers, services and knowledge are lower in larger and denser regions. This implies that economies of information flows (Acs, Audretsch and Feldman, 1992) on both the demand and the supply side are greater in large functional regions than in small ones. Thus, new high-tech firms are most likely to be started where the spillovers are greatest, and hence high-tech clusters are much more likely to emerge in large functional regions than in small ones.

In high-tech industries, a high share of the new ventures is started by former employees from incumbent firms using some of the technological know-how from their former employer (Klepper, 2001). This implies that existing high-tech firms characterized by a high level of technological know-how and continuous innovation provide a training

ground for future high-tech entrepreneurs (Franco and Filson, 2000). With mechanisms like this a high-tech cluster can secure renewal as well as continued growth.

1.1.2   *The dynamics of high-tech clustering*

In order to discuss the processes of high-tech clustering, we imagine a world where customers exhibit a demand for variety and where competition between firms has the character of monopolistic competition. We assume that high-tech clusters are initiated on a specific knowledge base, which is not generally available or whose potential is not fully understood elsewhere. This implies that the initiation of a high-tech cluster can be the result of either a technological advantage or an entrepreneurial advantage: a better understanding of the potential of a given technology. Thus, a high-tech cluster has a dynamic comparative advantage from the start, which, if the cluster is successful, tends to become greater over time.

Since a high-tech cluster is based upon a specific localized knowledge base, it is normally dependent on a local knowledge production base consisting of various combinations of research universities and public and private research laboratories. When the commercial applications of a specific knowledge base become obvious, that will normally lead to further investments in the knowledge base through basic and applied R&D and product development. Thus, the knowledge base expands with further strengthening of the dynamic comparative advantage. Assuming that knowledge production is characterized by fixed costs, as knowledge-producing activities expand they enjoy decreasing costs, resulting in increasing returns to knowledge production.

When a cluster is initiated, perhaps at the beginning, consisting of only one firm, the success of the early phase will stimulate imitation processes. Existing firms as well as groups of entrepreneurs will try to get into the market with products which are at least marginally superior to the original product. To the extent that these firms and entrepreneurs are successful, the high-tech cluster will expand. An expanding cluster stimulates an expansion of the knowledge base, which eventually increases the potential for developing and launching new product varieties. A growing cluster will also stimulate firms and entrepreneurs in other regions to develop activities in the cluster region. With more high-tech plants and firms in the region, the volume of R&D and product development increases as well as the demand for R&D from external knowledge producers. An increased volume of R&D implies that the possibilities to exploit scale economies in R&D grow. An increased volume of knowledge production implies an increased potential for various forms of knowledge spillovers, which stimulates the formation of new high-tech firms as well as growth among incumbents.

As the number of cluster firms grows and individual cluster firms expand, the demand for various inputs besides knowledge inputs increases. Existing supplier firms can now expand their production volume and take advantage of increasing returns. Lower production costs make it possible for supplier firms to reduce their prices, and lower input prices provide the customers with lower costs, which in its turn makes it possible for them to lower their prices and thus to expand their production. An increased demand for inputs not only opens up possibilities for incumbent supplier firms to expand, it also opens up opportunities for entrepreneurs to start new supplier firms and supplier firms in other regions to move operations to the cluster region, which over time will lead to an increased variety of inputs being supplied in the region. This will create better conditions for the

high-tech firms both to develop and to produce new products, since both these activities are dependent upon accessibility to a varied supply of inputs. Successful high-tech clusters might stimulate the emergence of clusters also on the supply side, some of which may also be high-tech, since high-tech industries normally demand high-tech inputs.

The developments described above are also relevant for the labour market. As we noticed above, high-tech clusters develop in regions with a specific knowledge base. Such specific knowledge is normally embedded in people with a higher education. When the high-tech cluster and related knowledge production starts to expand, the demand for the labour with the relevant specific knowledge will also expand with increasing wages as a consequence. The increased demand will stimulate more people to apply for relevant education and institutions of higher education to increase the relevant educational programmes. Since most education programmes are rather long, the excess demand for people with the relevant training can continue for several years and potentially limit the growth rate of the cluster. This temporal excess demand is normally partly remedied by in-migration of labour with the relevant training. This option is dependent upon the general supply and demand conditions for the actual labour groups as well as the willingness to migrate.

The emergence and growth of a high-tech cluster also has effects on customers. If the output of a high-tech cluster is the input of another industry, the expansion of a high-tech cluster has a distinct effect for the customers. As the cluster expands and takes advantage of internal as well as external returns to scale the price of its output will tend to decrease. This implies that the costs of its customers will tend to decrease. If the high-tech product is a critical input for the customers and if the technology involved necessitates face-to-face contacts between suppliers and customers, customers have an advantage of locating and expanding close to the high-tech cluster. Thus, the emergence and growth of a high-tech cluster might stimulate expansion among its customers as well as the establishment and location of more customer firms, which over time might develop to a cluster of its own.

The growth of high-tech clusters is also dependent upon other factors. Certainly, infrastructure is critical. Without a suitable intraregional transport infrastructure, with its arenas, meeting and market places, it is impossible to develop a labour market with commuting conditions, which are acceptable for an expanding cluster. These regional resources are also critical for direct and indirect knowledge flows and knowledge spillovers, necessary for the efficiency of a growing high-tech cluster. The problem with infrastructure resources is that they generally grow very slowly – much more slowly than the cluster – and thus can develop into a bottleneck for the future growth of the cluster. On the other hand, with persistent investments in infrastructure resources the conditions for clusters might on certain occasions go through qualitative changes, which open drastic new expansion possibilities for the clusters.

Since the large urban regions are concentrations of knowledge and of knowledge generation it is assumed that knowledge flows, including knowledge spillovers, are at the core of knowledge-based clustering. However, the knowledge that is critical for knowledge-based clustering is not freely available and transmitted at zero cost. Of course, some knowledge, so-called codified knowledge, which is written down in textbooks, manuals and so on and which is easily assimilated by anyone with a relevant background, can be more or less freely available at close to zero transmission costs. However, much knowledge

is tacit because it is the cumulative output of long periods of learning, specific to a particular setting, and cannot be written down and become codified. Transmission, sharing and exchange of codified knowledge is highly dependent upon face-to-face interaction.

Since knowledge is geographically concentrated (Audretsch and Feldman, 1996), location is crucial in understanding knowledge flows. In addition, the capacity to absorb flows of new technological (and entrepreneurial) knowledge is facilitated by geographical proximity (Jaffe, Trajtenberg and Henderson, 1993; Baptista and Swann, 1998). The exchange of ideas has been used as one major explanation for the clustering of economic activity and differences in income and productivity across geographic space (Marshall, 1920; Henderson, 1974).

Proximity is obviously essential for knowledge flows, whether they are transaction-based, transaction-related or spillovers (Karlsson and Johansson, 2006) for the following reasons:

- If the price of transaction-based knowledge flows is assumed to be distance-sensitive, knowledge transactions inside a region are more favourable than interregional knowledge transactions. Given this assumption, a proximity externality will exist, which stimulates knowledge buyers and suppliers to locate in the same region.
- If ordinary input purchases are assumed distance-sensitive, sellers and buyers of inputs have an incentive to locate in the same region. Consequently, transaction-related knowledge flows will be proximity-dependent.
- Pure knowledge spillovers are generally assumed to occur as a part of extra-market social interaction, which is considered distance-sensitive. Employees who shift between firms, bringing knowledge with them as they move, also cause this type of knowledge flow. Thus, proximity externalities will be associated with pure knowledge spillovers.

Large regions offer special advantages for knowledge-based clustering since they combine a large supply of knowledge with diversity and proximity and thus offer the best conditions for knowledge flows. When a large region has achieved an initial advantage in knowledge supply, that is, a pool of human capital, it will attract knowledge-creating and knowledge-utilizing firms and stimulate formation of knowledge-based clusters. The underlying reason is that such regions offer the best opportunities to take advantage of increasing returns in knowledge production.

Having discussed the traditional view of high-tech clustering one may also recognize another form of knowledge-dependence among high-tech clusters, which reveals itself as large input shares from knowledge-intensive input suppliers. When a knowledge-intensive cluster grows, it will lead to an increased demand for highly educated labour, which will stimulate knowledge-intensive labour to move to the region and more people to enter higher education. This implies an overall increase of the region's knowledge intensity. The cumulative consequence is that there will be interacting expansion of the job market potential of knowledge-intensive households.

1.2   Cluster case studies

A deeper understanding of clusters and clustering also demands an understanding of the internal life of clusters. There is a need to understand both the internal functioning of

clusters at a given moment as well as their internal development over time. To achieve such understanding there is no alternative to case studies. Actually, it is the nature of the issues to be analysed that determines whether case studies are the appropriate research method or not. The case-study method is the appropriate method when the goal is to cover contextual conditions and when the boundaries between phenomenon and context are not evident (Yin, 1994). Thus it is impossible, and indeed undesirable, to separate the phenomenon of clustering from the context within which it occurs (Branston et al., 2006).

However, making a case study does not imply an exploration of the unknown without any theoretical pre-understanding of clusters and clustering. Yin (1994) stresses the importance of theoretical analysis as part of the design phase of case studies. There are, as a matter of fact, various methods that can be used for analysing clusters and clustering, depending upon the theoretical perspective that is adopted.

For what research questions related to clusters and clustering then are case studies the appropriate research method? Starting with the internal structure and functioning of clusters, case studies are important for increasing our understanding of the detailed structure and functioning of the following:

- the cluster production system,
- the actual networks involving firm and non-firm actors within and outside the cluster and the degree and type of networking,
- the cluster innovation and learning system,
- the coordination and governance mechanisms within the cluster,
- the cluster labour market,
- the integration of the cluster in the interregional and international export and import networks,
- institutions and public policies for the structure and functioning of the cluster.

Studying the development of clusters over time is much more difficult. It is rare for researchers to have the endurance to make longitudinal case studies of clusters. Thus, most case studies of the development of clusters over time are retrospective studies, with all the problems inherent in such studies. The initial cluster formation phase is in principle impossible to study since no one actually knows that a cluster is emerging before it has got some significance. However, given the difficulties, it is still very interesting to get an increased understanding of the processes that are driving cluster development over time. In this case, case studies are important in gaining an increased understanding of the conditions and processes, including the role of institutions and public policies, which enable clusters to begin, grow, mature, possibly renew themselves and ultimately decline and disappear.

1.3   Cluster policies

Cluster policies are currently a hot topic. Policy makers in many countries at both the national and the regional level have come to believe that supporting and creating clusters is the major option to be competitive and to be a winner in the globalization race (Maillat, 1998; Lagendijk and Cornford, 2000; Lundvall, 2002). A search on the concept 'cluster policy' using Google in October 2006 gave about 38 500 hits. Certainly, there is a strong need for a thorough discussion of cluster policies and not least the rationale for cluster

policies. In many countries at the national, as well as at the regional and local level, cluster development has become the solution to economic development: cluster policies have become politically correct or at least politically opportune, since they are easy to communicate (see, for example, Andersson et al., 2004). However, in many (most?) cases, cluster development seems to be based on no or very limited analysis. Clusters are found and identified without any clear criteria. When criteria are used, they are often very simple, such as location quotients. Still worse, there is often very little analysis of what factors gave rise to the emergence of clusters, the factors keeping them together, the long-term prospects of the clusters, the fundamental reasons motivating political intervention, and the problems of applying cluster policies (Cf. Held, 1996).

A significant problem with cluster policies is that it is difficult to give general recommendations, since different clusters and clusters in different life cycle phases need different policy approaches. The types of inter-firm linkages, number and scope of industries represented in the cluster, cluster orientation (network or hub and spoke) and the relative position of cluster firms in the value chain will tend to differ between different clusters, which implies that the proper policy interventions will differ from region to region (Stimson, Stough and Roberts, 2006).

Existing clusters can often be efficiently supported by policies. Stimulating emergence of new clusters is substantially more complicated. Having witnessed the success of a limited number of successful high-tech clusters, many regions want to initiate and nurture their own. This is often done with little and mostly superficial analysis. Often the initiatives to create new clusters are based upon rather simple imitation strategies, which severely underestimate the difficulties of launching new clusters. The difficulties are real since research has had rather limited help to offer concerning the necessary and sufficient conditions for successful launching of new clusters.

However, clusters seem to contribute positively to real income levels in some regions. This can have important implications for regional development polices. The basic theoretical motivation for cluster policies does come from the endogenous regional growth theory, which emphasizes the importance of local and regional factors in creating and maintaining sustained development as opposed to those external to the region (Johansson, Karlsson and Stough, 2001; Stimson, Stough and Roberts, 2006). However, it is not obvious what the practical implications are, and how cluster policies should be designed (Karlsson and Stough, 2002). What type of regional cluster policy to apply depends on (a) type of cluster(s), (b) actual degree of cluster formation in the region, and (c) information and knowledge about existing clusters and cluster policies possessed by relevant political authorities.

In the ideal case, policy measures would be directed towards the causes of the problem to be solved. It is important to realize that externalities, which stimulate cluster formation, are a sign of a market failure. This holds irrespective of whether the externalities are pecuniary or technological. In traditional economic welfare theory, the existence of market failures has generally been taken as a motivation for political interference. However, this view has become more nuanced in recent decades. Political interference is associated with its own costs and these costs must be weighted against the benefits from removed or reduced market failures.

In the case of technological externalities, market failure is obvious. The individual firm has no incentives in its calculations to consider the positive (negative) effects for other firms

of its own activities. However, a merger or an acquisition might make it possible to appropriate some of the positive external effects, if it is possible to identify the winner. The individual small firm can rarely consider the value of its own activities for the cluster and even less for the overall national economy. This condition implies that, private companies in a market economy regularly underinvest in R&D, since it does not consider the value for other firms of its knowledge creation (see for example, Jones and Williams, 2000).

Pecuniary externalities, on the other hand, are market failures connected with scale economies or imperfect competition. The utilization of scale economies, the supply of products and the degree of competition are all limited by the size of the market potential. If more customers enter the market or if suppliers can better access distant markets, this limitation is reduced and a socioeconomic benefit arises through lower unit costs, a wider supply of products and/or increased competition. Thus, it is not the pecuniary externalities as such which represent market failure. It is just a symptom of a market failure, which comes from the production conditions (scale economies) or the market form (imperfect competition).

Certain market failures due to externalities can be avoided if the effects can be internalized, for example if the firms in a cluster decide to coordinate their activities through a common ownership or through contractual arrangements. Cluster firms can also organize themselves and work jointly to get more firms and/or households to locate in the region to increase its market potential, if the size of the market potential is too small for positive pecuniary externalities to be realized. There are, in fact, plenty of examples of the role that private sector leadership can play for cluster initiation and cluster development (Stimson, Stough and Roberts, 2006). However, if the number of economic actors is large it might be impossible to achieve internalization or to organize a private sector leadership. There are also limitations to what cluster firms can achieve. Many important policy issues, such as the building up of material and non-material infrastructures, in most countries reside within the public sector.

Obviously, there are two cases when public sector cluster policies might be considered under assumptions of perfect information. The first case concerns private sector coordination failures, where private sector coordination might be replaced with public sector coordination. The second case concerns suboptimal market potentials in regions with clusters, where public sector infrastructure investments can contribute to increased market potentials by means of the extension or merger of functional regions and/or better access to external markets. Coordination failures and/or underoptimal market potentials can result in clusters operating on a suboptimal scale or potential profitable clusters not being established. However, there might be a potential to develop public–private partnerships. Such partnerships can produce better coordination and concerted action within a cluster. The main reason is that they enable many economic agents within both the private and the public sector to act on the same information and to arrive at the same conclusions regarding suitable actions; that is, it produces a 'shared vision' linking individual efforts to a consensual goal (Stimson, Stough and Roberts, 2006).

As a cluster consists of those firms which are best able to take advantage of a region's market potential and its durable resources, regional cluster policies should primarily focus on supporting and developing existing clusters. Owing to the existence of positive externalities, the existing clusters in a region will normally not achieve an optimal scale spontaneously. To the extent that existing clusters are not capable of driving a region's

development, it is natural to raise questions about new clusters and thus the possibilities for structural change in a region through cluster substitution (Venables, 2001).

Even if there might exist basic welfare arguments for cluster policies, there is still the underlying problem that the relevant authorities often lack necessary information and knowledge about the following:

- the character of the cluster benefits,
- what the exact causes of the cluster benefits are,
- which clusters generate particularly strong cluster benefits,
- what actually constitutes the coordination problem, and
- the role of intra- and interregional market potentials for clusters.

Furthermore, there are other problems related to cluster policies, which have to do with the risks of manipulation, lobbying and the existence of asymmetric information.

Another problem related to cluster policies is that different economic processes work on different time scales. Product markets, for example, normally change through relatively rapid processes, which generate demands that durable regional characteristics, such as the labour force with its pertinent skills, real capital, infrastructure capital and so on, must be adjusted to. As competition to its character is dynamic, there is a constant need to upgrade the regional economic milieu of clusters. The problem is that such capacity and quality adjustments are a slower and above all a more indolent process than the processes in the product markets (Johansson and Karlsson, 2001). If the lags in the development of labour supply, built environment and infrastructure are long, the growth of clusters may be retarded and rapidly turn into a negative phase. The possibilities to counteract lags in the capacity and quality adjustments and to create conditions for a sustainable cluster growth rests on long-term and credible regional cluster and other development policies: these policies must be capable of reducing the uncertainty among the economic actors in the cluster about the future growth prospects of the cluster.

According to the modern theory of endogenous regional economic growth, cluster growth depends upon internal regional conditions, which can be influenced by policies (Johansson, Karlsson and Stough, 2001). In line with this view, cluster policies and general regional development policies deal with conditions which essentially must be developed and implemented with region-specific knowledge as a base. Thus, cluster policies must be implemented at the regional level even if a more comprehensive view and financial support might come from the national level.

Internal economies of scale mainly rest outside the domain of economic policies. However, policies leading to lower fixed costs for labour and capital reduce the dependence of firms on the size of the regional market potential. Moreover, to get new clusters running it is important to create optimal conditions for start-ups, spin-offs, spin-outs and firm growth. It is also important to create a clear vision and strong image for new clusters by means of a conscious and profiled marketing.

Our focus here is on the internal and external market interaction of economic agents in clusters and the pertinent costs are called 'transaction' costs. Many products are exchanges under complex (and contact-intensive) transaction conditions, which may involve many transaction phenomena, such as inspections, negotiations and contract discussions, legal consultation and documentation of agreements. Such products may

themselves be complex, and have a rich set of attributes, but the basic thing is that, from a transaction point of view, they are not standardized, and the interaction procedures are not routine procedures. Geographic transaction costs are defined as comprising both transportation costs and transactions costs, which vary with regard to the geographical distance between seller and buyer, and the properties of each spatially specific transaction link (Johansson and Karlsson, 2001).

The geographical transaction costs are partly determined by the infrastructure and transport policies, which in many countries are determined at the national level. Lower geographical transaction costs extend the borders of functional regions and increase the regional market potential, which creates scope for the development and growth of more industries and clusters and of firms with internal economies of scale. Transport costs are becoming an increasingly important factor for the development of clusters as other costs connected to international trade decrease. It is important to observe that the profitability of investments in infrastructure is larger in regions with clusters than in regions without clusters. Normally cost–benefit calculations of infrastructure investments used disregard this.

Other geographical transaction costs than transport costs are, among other things, a function of the formal and informal institutional framework at the international, national and regional level. Examples of institutional reforms that may reduce geographical transaction costs are standardization of contracts, products and so on. However, the geographical transaction costs might also be reduced by the provision of strategic leadership, arenas for networking, networking brokers and market intelligence (Stimson, Stough and Roberts, 2006).

Large parts of the knowledge generation in a region are characterized by collective characteristics. Knowledge developed by one firm tends over time to diffuse to other firms in the region. This generates increasing returns in the regional economy as a whole, that is, the growth of the regional economy can be influenced by investments in knowledge, R&D and human capital. Even if there is no one-to-one relationship between knowledge intensity and profitable clusters some authors argue that there are strong reasons to believe that clusters are more common in knowledge-intensive industries than in other industries. This implies that, if a region wants to stimulate cluster growth and cluster formation, there are strong reasons for public investments in higher education and R&D. It is important to note that, in this case, precision is more important than volume. The investments in higher education and R&D must be cluster-relevant. However, even if countries and regions want to see knowledge-intensive clusters develop, it is important to realize that many successful clusters cannot be characterized as knowledge-intensive. In various countries, we find clusters focused on wood products, furnitures, shoes, textiles, clothes, plastics and so on. It is not at all certain that the best way to develop clusters like these is investments in higher education and R&D.

1.4   The contents of this volume

This volume is organized in three parts and the content of the chapters making up these three parts is briefly described below.

1.4.1   *High-tech clusters*

In Chapter 2, James Simmie claims that, over time, there have been major shifts in Michael Porter's conceptualization of clusters. In the earlier works of Porter, clustering is seen as

a highly localized set of processes in which firms interact with competitors, suppliers and customers in such a way as to drive up competitiveness. In his later works, Porter recognizes the growing significance of globalization and argues that it is clusters that are able to export that may be considered as truly competitive. However, the conclusion of this chapter is that there are few truly local clusters and that most clusters are in reality parts of value chains located in many places.

Colin Mason, in Chapter 3, develops the proposition that entrepreneurial activity has been the central mechanism in the emergence of high-tech clusters. He maintains that the genesis of most technology clusters can be traced to a few individuals in a region who left existing organizations in order to start their own companies to commercialize technological advances that they had been exposed to in their employment. Once seeded, the cluster becomes part of a self-reinforcing cycle. Spin-offs of this kind generate innovations, which differ distinctively from the products of the parent company. As such, they provide a source of diversity.

The aim of Chapter 4 by Mario A. Maggioni and Massimiliano R. Riggi is threefold. The first aim is to discuss the empirical identification and measurement of innovative industrial clusters. The second aim is to present a theoretical framework for the analysis of the development of clusters. The third aim is to analyse the dynamics of a restricted sample of high-tech industries across the US over the period 1988–2003 in order to test the empirical relevance of such a definition on both the spatial concentration of industries and the industrial specialization of different states.

In Chapter 5, Bernard Fingleton, Danilo Igliori and Barry Moore analyse employment growth in information and communication technology (ICT) clusters. In particular, they analyse the causes of differentiated employment growth in small ICT firms with an emphasis on the role of horizontal clusters using data for Great Britain for the period 1991–2002. Using firm data, they apply simple weighted OLS regressions but retain a spatial perspective. Their results indicate that there is a significant association between the intensity of horizontal clustering and employment change.

Helen Lawton Smith, in Chapter 6, analyses a number of important questions related to inter-firm networks in high-tech clusters. What kind of networks exists in high-tech clusters? How do such networks emerge in high-tech clusters and how are they organized? What is their life cycle? How sustainable are networks? What are the outcomes of networks? What effects do they have on innovation and economic performance? What do these discussions tell us theoretically and empirically about inter-firm networks in high-tech clusters?

Chapter 7, by Gil Avnimelech, Dafna Schwartz and Morris Teubal, deals with the evolution of the Israeli startup-intensive high-tech cluster of the 1990s and its relationship to the Venture Capital (VC) industry. VC is considered as an industry, which evolves over time while coevolving with the high-tech cluster. The authors focus on the dynamic processes that facilitated and triggered the VC industry and high-tech cluster development process. The cluster development framework used is based on the evolutionary economics perspective, the product life cycle perspective and the cluster development literature.

Universities and other higher education institutions have long been considered a key element of knowledge clusters as a source of qualified manpower, and of technology. As is shown in Chapter 8, by Jérôme Doutriaux, even if they are not always necessary for cluster emergence, they are needed for growth and sustainability. Except for world-class universities,

most university–industry linkages take place at the local or regional level. University research spillovers vary from sector to sector and are most efficient in large clusters already active in research and with a culture and mechanisms supportive of networking.

Based upon a broad review of the relevant literature, Stefano Breschi, in Chapter 9, points out some of the most important unresolved issues in the understanding of the relationship between clusters and innovation. In this chapter he sketches a very simple model of patenting and R&D, which serves as a benchmark to evaluate the degree of clustering of innovations and its determinants. He undertakes a thorough statistical analysis of the spatial distribution of innovative activities and provides an econometric approach to the analysis of the determinants of innovation-specific agglomeration economies.

1.4.2   Cluster case studies

Chapter 10, by Arne Isaksen, deals with one of the emblematic industries of the knowledge economy, namely the software industry. The software industry relies largely on highly educated employees and is also an innovative industry. This chapter explores three main questions related to the concentration of the Norwegian software industry in the Oslo region: (i) which activities constitute the software industry in the Oslo region?, (ii) how can the clustering of the software industry in the Oslo region be explained?, and (iii) to what extent does the Oslo software cluster influence the performance of software firms in the Oslo region compared to similar firms in other parts of Norway?

The basic idea in Chapter 11, by Mats Lundmark and Dominic Power, is that knowledge and learning most commonly develop through interactions located in the workplace. In the chapter, they outline some of the theory and findings that support the idea that labour mobility is crucial to clusters. An internationally competitive and knowledge-driven industrial cluster is also a dynamic and flexible labour market. The authors demonstrate their point using the example of labour market mobility in one of the most prominent industrial clusters in Sweden: the Stockholm information and communication technology (ICT) cluster.

Joseph Leibovitz, in Chapter 12, highlights the major locational dynamics affecting the biotechnology industry in Scotland, with particular reference to Scotland's two largest urban agglomerations: Edinburgh and Glasgow. The main emphasis is on establishing a dynamic, rather than static, snapshot approach to locally based cluster research, one that is attuned to the interplay between historical legacies and key events, the diversity of urban economic and social assets, and the linkages between the competitiveness of biotechnology firms and the urban environments in which they are situated.

In Chapter 13, Peter W.B. Phillips, Camille D. Ryan, Jeremy Karwandy, Julie L. Graham and Tara Williams explore the cluster horizon by providing an overview of select agro-biological and other agro-based clusters in practice. In particular, they explore the Saskatoon biotechnology cluster in Canada in the form of a case study compiling both qualitative and quantitative elements of cluster history. They analyse structure and development including factors such as the role of backward and forward linkages as well as the role of thick labour markets.

On the basis of combined insights of international management and network theories, Lilach Nachum, Robert Laud and David Keeble in Chapter 14 seek understanding of the network behaviour of foreign affiliates. They focus on a specific kind of networking, the one taking place between firms based in geographical proximity. Comparative analyses of

foreign and indigenous firms in the professional service industries located in Central London are used to isolate the networking attributes of service firms in general from those that are unique to foreign affiliates.

In Chapter 15, Harald Bathelt and Caroline von Bernuth analyse Leipzig's media cluster. They show that Leipzig's media cluster underwent severe crises and periods of restructuring during the twentieth century. What they argue is that firm formation and relocation processes have given rise to a new media industry cluster since the unification. This development has greatly benefited from a supplementary process of institution building in the region. However, evidence is also provided that neither the social relations between the actors in the cluster nor those with external actors are well developed, establishing a barrier to future growth.

Another case study of a media cluster is presented by Diane Perrons in Chapter 16. Her chapter outlines a holistic framework for economic geography, which focuses on understanding social and spatial divisions, by drawing on economists' ideas about the new economy and feminist perspectives on social reproduction. A prime motivation for her approach is her observation that economic inequality is increasing but has been sidelined in some of the recent debates in urban and regional studies. The framework presented is illustrated with reference to the emerging new media cluster in Brighton and Hove, which, as a consequence, emerges less as a new technology cluster and more as a reflection on increasing social divisions in the new economy.

The purpose of Chapter 17, by Andrew Cumbers, Danny MacKinnon and Keith Chapman, is to contribute new empirical evidence to the debate in the regional development literature about the role of collaborative relations and geographical proximity in stimulating innovations. Their empirical evidence comes from a case study of small and medium-sized enterprises (SMEs) in the Aberdeen oil complex. While finding some evidence to support the role of localized forms of collaboration among the most innovative SMEs, their results also indicate the importance of extralocal networks of knowledge transfer.

Maryann P. Feldman in Chapter 18 outlines the development of an entrepreneurial culture in the US capital region and the formation of a regional industrial cluster. According to her, the conditions that the literature associates with entrepreneurship lag rather than lead the development of the cluster. Supportive social capital, venture capital and entrepreneurial support services, as well as actively engaged research universities, are conditions that reflect the successful establishment of an entrepreneurial culture, built by the actions of pioneering entrepreneurs who often adapted to constructive crisis.

Chapter 19 by Guang Yang, Roger R. Stough and Kingsley E. Haynes focuses on the spatial analysis of clusters, and in particular on the relationship between their spatial and their sectoral or functional structure. The authors develop a plant-based approach and a related methodology to investigate the relationship between spatial and functional clustering. A comparative case study approach is employed to examine the relationship in the Washington, DC and Baltimore, MD metropolitan regions in the US and the authors find support for the hypothesis that there is a relationship between the spatial and functional structure of clusters.

1.4.3   Cluster policies
Ulrich Blum in Chapter 20 shows that transaction costs and external economies, which change the institutional arrangements, heavily influence cluster structures. He

distinguishes two types of clusters, (i) the vertical cluster where a hub dominates suppliers that are settled in the vicinity, and (ii) the horizontal cluster where firms have a common platform such as knowledge or labour. He shows how changing transaction costs and externalities influence clusters and produce cluster dynamics and how the sustainability of a cluster depends on its ability to stabilize the basis of its existence.

Chapter 21, by David A. Wolfe and Jen Nelles, reports on the results of a comprehensive study of industrial clusters across the Canadian economy designed to investigate a range of factors that contributes to the development of those clusters, including (i) the role local institutions and associations play in fostering the development of innovative and dynamic clusters, (ii) how dependent local firms are on unique local knowledge assets, and (iii) how each local industrial concentration evolved over time to reach its present state. Drawing upon the results from the case studies, the authors in this chapter present an overview of the key role played by civic associations and civic actors in cluster development.

Strategies and policies designed to foster the development of competitive groups of linked businesses within regional economies remain very prominent in recent policy-related research on regional development. Frank Peck and Christine E. Lloyd in Chapter 22 present an overview of the ways in which policy makers in different regional contexts have interpreted the notion of clustering and discuss some of the issues encountered in implementing such strategies. They then examine some recent contributions to the academic debate that appear to challenge the usefulness of the concept of clustering. They conclude by reconsidering developments in cluster strategies and evaluating the usefulness of the concept as a basis for intervention in regional economies.

In Chapter 23, Philip Cooke examines the knowledge management mechanisms in which dedicated biotechnology firms use embeddedness to tackle the R&D or 'drug discovery' process. He assesses the adequacy of these mechanisms and how industry and intermediaries judge they need to be strengthened and discusses the demise of 'discovery' methods and the rise of 'rational drug design' and fine chemistry versus molecular biology. At the end of the chapter he investigates regional development and management control issues arising from clustering of advanced bioscientific knowledge exploration and exploitation in a few globally significant 'megacentres'.

Gert-Jan Hospers, Frédéric Sautet and Pierre Desrochers in Chapter 24 ask if there is a need for cluster policy. After a critique of the concept of clusters, they argue that cluster policy is a form of industrial policy in that it still implies a form of targeting, i.e. selection of sector and industry. They also discuss the general pitfalls of cluster policy as well as the risks associated with policy towards high-tech as well as low-tech clusters. To support their arguments they present case examples of successful clusters in which government played no role or only a limited one in the field of cluster branding.

Note

1. To shorten the text we write 'urban region' instead of 'functional urban region'.

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