3 Cluster Dynamics

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3.1 Introduction

This contribution is partly based on a workshop on 'cluster methodology', organized in July 2002 for the Dutch Ministry of Economic Affairs. It focuses on cluster dynamics: how do clusters develop? It is structured as follows. First, it considers a variety of definitions of the notion of a 'cluster' and the content and aims of a cluster. Second, it asks what perspectives there are 'after Michael Porter'. The main shortcoming of Porter's concept is that it does not give any insight into the development of clusters and thereby offers almost no basis for public policy. Thus, a priority is to develop an insight into cluster dynamics by using a theory of learning and innovation developed in earlier work (Nooteboom 2000).

3.2 Definition of clusters

Which definition of clusters is seen as the 'correct one' strongly depends on the scientific background of the researcher and on the purpose of the study. While economists and management scholars emphasize the economic and technological features of a cluster, spatial economists and geographers emphasize spatial effects of localization. Some, partly overlapping, definitions of clusters are the following:

- Marshallian 'industrial districts'
- regional concentrations of related activities, including a knowledge infrastructure.
- structures of supply
- networks of firms with more or less durable linkages
- input-output connections between industries
- a portfolio of technologies
- firms connected with a certain domain of technology

According to Boekholt (Technopolis), a cluster is a group of firms that share certain characteristics, such as:

R.A. Boschma and R.C. Kloosterman (eds.), Learning from Clusters: A Critical Assessment, 51–67.

- a product or service to which all parties contribute (e.g. an automobile cluster)
- a technology which all parties employ (e.g. a biotechnology cluster)
- a combination of the two (e.g. multimedia or biomedics)

According to Belussi:

> 'The positive performance of firms may be related to the local context, where firms have developed a network of historical, path-dependent, locally based, specific interactions: a nexus of productive relationships, and a wide net of social relationships conducive to fast innovation activity.'

According to Visser (2002):

> Clusters are geographical concentrations of firms involved in similar and related activities (according to Porter 1998, Enright 2001)

According to Gault (2002):

> Clusters are groups of private and public institutions linked together for a common purpose, which may be innovation

Cooke offered the following definition, which was considered useful by many participants of the workshop, and which we will employ (Cooke & Huggins 2002):

> *'Geographically proximate firms in vertical and horizontal relationships involving a localized enterprise support infrastructure with shared developmental vision for business growth, based on competition and cooperation in a specific market field'*

This definition is useful because, among other things, it provides a possible handle for policy: the facilitation of a 'support infrastructure', the furthering of a 'shared vision' and the (sometimes paradoxical) task of furthering both competition and collaboration. However, when contemplating this definition, one should keep in mind the importance of external linkages in a globalizing world (Paivi Oinas). Here, the dynamics of clusters becomes crucial: as they emerge and grow an expansion of input and output markets, distribution systems and knowledge sources is needed (Boschma & Lambooy 2002).

3.3 Content and aims of a cluster

There was consensus in the workshop that there is an especially important distinction between two levels of analysis. The one concerns the meso-level of industries that are connected in input and output, in a country or region. The second concerns the micro level of individual actors (firms, public bodies, individual people), embedded in specific, local conditions (markets,

institutions, agglomeration, urbanization). This distinction has consequences for all the questions that were put to the workshop concerning clusters: their definition, identification, data, methods of research, dynamics en policy. The micro level concept includes spatial effects of localization, while the meso-level concept does not. As regards policy, at the meso-level one could consider central, national industry or technology policy, while at the micro level one could consider local bodies (provinces, municipalities) for the configuration of actors and for the local support infrastructure. To avoid terminological confusion, we reserve the notion of a cluster for the micro level. This does not imply that there is no connection between the two levels. At the micro level, knowledge of industries, technologies and markets remains important. Results from the one level can yield insights for the research agenda at the other level. Thus, research on the relationship between service and manufacturing industries, in innovation, (Broersma 2001) suggests that one might also consider such relations at micro level since clusters entail connections between manufacturing and services at that level as well. In the remainder of this chapter the focus is on clusters at micro level, because it is especially there that the dynamics of clusters and the role of firms emerge.

A cluster often includes (parts of) different value chains. A *value chain* contains all firms that add value in the production and marketing of a given product. For example, to make potato chips one needs the growing of potatoes, an auction, transport, distribution centers, machines to cut the potatoes, etc. This entails a multitude of related sideline activities that connect with other value chains. Together, these constitute a *value system*. For example, potatoes also form an input for chemical industries, with a wide variety of end products. In strain-improvement there may be cooperation with commercial research institutes and universities, growers and patent specialists, to keep up with fast technical development. There is also collaboration with formal and informal investors and R&D subsidies are used to support risk taking. Thus, there are not only connections between value chains, but also with supporting institutions.

A *network* is a collection of collective and/or individual actors who are connected in a certain structure (with characteristics such as size, density, structural holes, centrality) with ties that may have a variety of content and strength. The 'density' of a network indicates the extent to which participants have direct connections (Coleman 1988). With participants, the maximum number of direct connections is n(n-1)/2. Density is measured as the actual number of such connections, divided by the maximum. Few direct connections entails 'structural holes' (Burt 1992). Parties may be connected indirectly by

being members of the same association, of the same value chain, or by sharing customers or suppliers. There is high centrality in a network when one or a few members have many direct connections to others that themselves have few connections. In a network, linkages or ties can be more or less strong, more or less formalized (in contracts or hierarchy of ownership) and more or less based on trust.

A network is a general concept which includes value chains, value systems and clusters. Thus, a cluster is a network of a certain kind. For example, a network of members of supervisory boards of a corporation is a network but not a cluster, though it may be part of one. A network may consist of a well-delineated, small group of firms. Often these are similar firms around a supplier (e.g. a franchise), or different ones around a user (a supplier network). The aims of networks may be simple information exchange, joint advertising, distribution, political lobbying, joint product development, or joint research. Simple aims, such as information exchange (e.g. in personnel management, quality assurance, market information) are often achieved in informal networks or knowledge platforms, perhaps provided by industry associations. More complex aims, such as the development of a new technology, or the sharing of strategically sensitive knowledge, are often taken up in smaller, tighter forms of collaboration (2 to 5 partners). These may emerge from or may be part of larger networks.

When does a network become a cluster? In a cluster, *different types of activity* are often combined, with a *shared purpose*, in *vertical, horizontal, and lateral linkages*, including *linkages with markets of inputs and outputs and with institutions* (see the above definition offered by Phil Cooke). There is also the idea that a network with high centrality and hierarchy or asymmetric dependence would no longer be called a cluster. An example would be an arrangement of more or less captive activities around a central coordinator, in a hub and spoke structure. The network of a cluster makes the cluster more than a collection of firms that happen to be in the same location, industry or technology. The network yields added value by synergy effects of complementary competencies or assets, for improved products, efficiency or market access. In a cluster there is a joint purpose, but there are also individual purposes which may be in conflict with each other, while there is *no overarching authority* that yields hierarchical control. There is dependence but it is overall, mutual and more or less balanced. Thus, the notion of a cluster is loaded with an appealing connotation of equality or democracy and a lack of suppression which may be part of its attraction as a concept and thereby might inspire wishful thinking rather than a realistic model.

While the conceptual boundary between networks and clusters is not always sharp, it does yield considerable scope for distinction. A franchise or supplier network, mentioned before, would not by itself be a cluster for two reasons. One is lack of variety of activities. The second is that franchises and supplier networks are typically dominated by the franchiser or the buyer, in principal-agent relationships. In the same vein, we would not call the 'Benetton cluster' a cluster if the network were actually governed by Benetton as the principal and the autonomy of other actors were to be constrained in the sense that they act largely as agents for the principal. The flower cluster in the Netherlands has a limited joint purpose, in the collection of flowers for auctioning. Yet we call it a cluster because of the diversity of activities brought together, the joint purpose, limited as it is, and the lack of a hierarchy.

In a cluster, the joint purpose may be limited, and *tight and loose ties may co-exist*. Cluster members do not have to know each other, need not all have direct connections and do not all collaborate with everyone. However, they are connected - at least indirectly. The strength of ties has several dimensions (Nooteboom 2003): scope, i.e. the type and range of activities involved in the tie, intensity, i.e. commitment of financial or other resources, the relation-specificity of investments, frequency of contact, duration of the tie, exclusiveness (lack of other direct ties) and mutual commitment or loyalty.

The final word has not been said on the distinction between cluster and *'industrial district'*. They appear to share the features of connectedness, shared purpose, variety of activity, limited hierarchy and centrality, and local embeddedness. However, a 'district' suggests that activities are bound to a region and cannot have an extended spatial reach. The notion of a cluster does allow for that and this may indeed be a crucial feature of cluster dynamics.

3.4 Perspectives 'according to Porter'

A dominant concept is that of Porter's (1990) 'diamond'. The main value of the concept is that it is simple and appealing and therefore useful as a 'sensitizing tool' to indicate the importance of: connections with markets of inputs ('related and supporting industries') and outputs ('demanding consumers'), firm conduct ('strategy and rivalry') and the 'local context'. However, it does not offer much assistance when it comes to acquiring a more concrete insight into the working and the development of clusters. A problem with Porter's notion of a cluster is that it covers so many divergent situations and configurations (Martin & Sunley 2001).

Porter's work does not give much insight into the working of clusters at micro level. As regards the local embedding of clusters, one should recognize that there can be considerable differences between types of clusters depending on the types of market and technology involved and on a cluster's stage of development. In biotechnology, for example, geographical roots are of limited importance. From the beginning of development, it operates in an international arena. Thus, there also appears to be a distinction between international and national clusters. 'Embedding' need not always be tied to location and can also occur in 'communities' that are to some extent virtual, with frequent travel and communication at a distance. A central question is whether impulses for innovation come from inside or from outside, and how this depends on stages in the development of a cluster. Especially at the early stage of cluster development, frequent meetings are needed to establish the trust that is required, especially at that stage. However, as clusters develop, they typically have to extend their geographical reach and must become dis-embedded to some extent. This is related to the condition that in later stages the basis for governance of relations tends to shift from informal, trust-based governance to more formal, contract-based governance, as we will argue later.

The main objection to Porter's notion of clusters is that it does not provide an insight into the dynamics of cluster development: their emergence, development, growth, stagnation, decline or transformation. The consensus in the workshop was that the most important policy issues lie in cluster dynamics. An important question is, in particular, when local embedding is needed/useful, and when a cluster should reach out in the context of globalization (Boschma & Lambooy 2002). At that stage, the role of national policy becomes dubious. Cluster dynamics also has important implications for a cross-national comparison of clusters. If one can meaningfully compare clusters only in the same stages of development, how does one identify those stages, and how can one gear evaluation to them? We will return to that question later.

3.5 Identification of clusters

Within the general characterization of (micro-) clusters according to Cooke, a further refinement is needed, on the basis of, among others (Oinas 2001ab, Oinas and Malecki 2002):

- The type of activities on which clustering is based: the specific competence and resource needs

- the relation between new and mature activities, the degree of renewal (radical or incremental), and their relation to existing structures
- the nature of the local context: specialized or diversified, agglomeration and urbanization effects
- the structure of the cluster: density, closure (barriers for entry and exit), heterogeneity, diversity of knowledge and 'cognitive distance' (Nooteboom 1999, 2000), presence of central actors, the presence of structural holes, and the bridging of them to generate Schumpeterian 'novel combinations', and to generate access to markets of inputs and outputs.

Cluster analysis requires a combination of a perspective of *competence* and a perspective of *governance*. These are both connected with the structure and the embeddedness of the networks in a cluster. We will also argue that cluster dynamics is associated with shifts in both competence and governance. The first aspect, that of competence, depends on the nature of knowledge (tacit or codified), the capacity of parties to absorb each other's knowledge (absorptive capacity, cognitive distance), the radicalism of innovation, the measurability of inputs-outputs, the question of whether technology is 'systemic' (with strong, tight constraints on interfaces) or 'stand-alone' (Langlois & Robertson 1995). The nature of knowledge, cognitive distance and absorptive capacity affect 'dynamic transaction costs' in the sharing or transfer of knowledge. The degree to which technology is systemic affects the structure of networks in a cluster and the nature of ties: the density, strength and duration of ties and the possible need to guard systemic coherence. The aspect of governance relates to 'relational risk' and instruments to manage them. Relational risk can result from dependence due to a lack of alternative options (monopoly/monopsony), or from specific investments (which can yield the 'hold-up' problem) and problems of appropriability and spillover: the danger of a partner running off with one's knowledge. Possible instruments for governance are, hierarchical control, contracts, hostages, balance of dependence, go-betweens, reputation mechanisms and trust (Nooteboom 1999).

The connections between competence, governance and structure can be illustrated as follows. In a dense cluster, with many and strong connections and few structural holes:

- there is much 'redundancy' of relations, which may add little value (Burt 1992)
- the redundant relations provide a strong reputation mechanism, yielding a basis for trust and possibilities to craft coalitions to limit opportunism.
- the strong ties give a basis for the building of relation-specific trust.

- there are many avenues for spillover
- there is a basis for detailed, efficient division of labour
- there is a danger of exclusion of innovative impulses from outside, the decline of cognitive distance and variation of knowledge and the lock-in of parties, preventing them from exiting and establishing novel outside ties.

An important issue is the delineation of clusters. The following possibilities were mentioned:
- economic-geographical boundaries
- actors within the boundaries should have a significant tie with the 'core' of the cluster
- a 'portfolio' of related technologies or technical trajectories.

A question here is what one understands by the 'core' of a cluster and a 'significant' tie. A tie can refer to streams of products, information, investments, ownership or supervision (the 'scope' of the tie). Which ties matter depends on the aim of the study and on the issues of competence and governance mentioned before. One pitfall is to exclude 'peripheral' actors, with few direct connections with the cluster 'core', only because they are peripheral. In the light of the above discussion, of the importance of bridging structural holes, a peripheral actor can be of crucial importance if he provides a connection with other clusters or networks, as a 'boundary spanner'. An example is an actor who contributes little technology but provides vital access to a distribution channel.

3.6 The specificity of cluster development

The dynamics of clusters is connected with cluster-specific, local conditions, issuing from a history of development which can cause problems for the transplantation of a successful form from one institutional context to another. A cluster may arise as a compensation for local weaknesses that do not arise elsewhere. Several examples can be given. The widely applauded development of networks or clusters in Italy can be attributed, at least in part, to a lack of reliable legal institutions and a climate of corruption. Then there is no opportunity for generalized institutions-based trust and one has to fall back on personalized trust in specific relations. The emergence of some clusters was due to the lack of public research institutions (Belussi). Moreover, one

cannot conclude from the success of those clusters that we should break down our public R&D institutions in order to enable the development of such clusters in the Netherlands. One should beware of ambitions for a generic blueprint for clusters that can be applied anywhere. Clusters yield solutions to specific problems/opportunities and clustering gives parties an ability to solve specific problems in specific contexts. This connection between performance and local, historically grown institutional conditions yields problems not only for the transplantation of cluster models, but also for their international comparison. This does not imply, however, that nothing can be done. It implies that we must look closely at past and present conditions, in our evaluation of the need, viability and performance of clusters, in relation to alternatives.

A second aspect of the dynamics of clusters is that a cluster should not be seen as a once-and-for-all arrangement. A key question is how clusters can adapt to changing internal and external conditions. The question now is whether, in spite of the local specificity of clusters, we can still identify general stages of development and can develop a battery of measures to assess performance by stage of development. Here also we do not expect one universal path of development (Boschma & Lambooy 2002). Yet, it seems possible to identify an underlying 'logic of development' from which different paths of development can be derived. Such differences depend, again, on contingencies of technology, knowledge, markets, institutions and instruments for governance. We will outline this logic, with different possible configurations of the three aspects - competence, governance and structure (Nooteboom 2000) - that we indicated before for different stages of development.

In spite of these caveats concerning the local specificity of clusters, we propose that a cluster that emerges from new technology market combinations will in general develop in four stages, namely exploration, consolidation in a dominant design, exploitation and subsequently a possibility of stagnation and a possibility of transformation for renewed exploration. In the exploration stage we can make a distinction between technological exploration, followed by an exploration of organizational forms for exploiting emerging technology. That leads to dominant designs in technological standards, organization and surrounding institutions. In the exploitation stage we can distinguish between local exploitation and market expansion, with adaptation of the organization in different markets which, in turn, can form the basis for new exploration (Nooteboom 2000, Gilsing & Nooteboom 2002).

3.7 Exploration

The first stage of exploration often goes together with organizational disintegration: new elements that do not fit in existing structures (of production, organization, market, distribution channels, institutions) need to shield themselves off in a niche where deviation from established structure and process is feasible. In terms of innovation theory: disintegration is needed to allow for the variety needed for Schumpeterian 'novel combinations', in 'creative destruction'. In terms of evolutionary theory: novel species often arise in seclusion from the niche of their parents, in 'allopatric speciation' (Nooteboom 2000). This often requires the emergence of new firms which are not imprisoned in existing structures and interests, spin-offs from existing firms that try to escape from such prisons, or 'external corporate venturing' where large companies facilitate spin-offs that may be temporary, with the option of later re-integration into the parent company. Relations between such more or less autonomous units are needed in order to utilize complementary competences, spread risks and develop a joint momentum. In the beginning, the focus is typically on technical feasibility. In this stage there is considerable uncertainty about technical success, the design and standards that will ultimately prevail and the market. Competence includes the ability to deal with such uncertainty. At this stage, knowledge is often tacit. Parties have to invest in each other to cross cognitive distance, building mutual absorptive capacity in the process, and to build trust in competence and intentions. This requires a certain intensity and frequency of interaction. However, what is important in this stage is the maintenance of flexibility of configurations in technology, product and organization, the utilization of diversity of knowledge, and cognitive distance. Note, here, that variety has two dimensions: the number of different units and the size of differences between them ('distance').

For governance, the high level of uncertainty severely restricts opportunities for detailed formal contracts and monitoring. There is not yet a relevant reputation mechanism in place. In view of uncertainty concerning future relations and dependencies one will, however, be motivated to build up a good reputation. It is not yet clear to what extent investments will turn out to be specific or generic. The need for mutual understanding, risk sharing and joint exploration goes together well with the need to build trust, in interaction. As is known from the trust literature, high mutual need stimulates the building of trust. Ties between partners are strong, in terms of intensity and frequency of interaction, but are not so durable as to block re-configurations needed in the

exploration of novel combinations. The network may be dense, but it remains open, with new bridges crossing structural holes between newly linked fields of knowledge. The network is limited in size and is locally embedded. The reason for this is that one cannot rely on existing insights and standards, there is no reputation mechanism in place, contracts are limited, one has to make use of local gossip and has to be closely connected for the sharing of tacit knowledge and the building of personalized, relation-specific trust. Spillover risk is present, in principle, with the chance that partners expropriate knowledge. The tacitness of knowledge that often accompanies this stage limits spillover, but spillover can still take place by poaching staff, or by staff spinning off in a venture of their own. However, it may be that in this stage knowledge changes so fast that by the time a potential competitor has absorbed and implemented it, the knowledge has already shifted. As a result of the limited size of the network, the reach of possible spillover is limited to a small group of insiders, where reputation is important. Within that group of intensive ties, knowledge is likely to spillover anyway, so that spillover is not necessarily an argument not to collaborate. In view of intensive interaction, within the core of the cluster, there is also an opportunity to monitor closely what happens to knowledge when it is exchanged. Furthermore, in this stage of market uncertainty, production for a market is hardly relevant yet. Moreover, there tends to be symmetry in risk of both hold-up and spillover, as a result of mutual specific investments because all participants need to make specific investments in mutual understanding and trust building and need to exchange sensitive knowledge in order to employ opportunities for complementarity. Opportunism can be retaliated against and that deters opportunism. Sensitive knowledge can be used as a hostage. A potential problem in this stage is that, in the absence of a clear selection mechanism in a market, for lack of clear demand, one may be unable to get out of a 'chaos' of successive, proliferating, competing designs, which further hinders the emergence of demand, since potential users postpone purchase until a dominant design has emerged. In other words, technical and commercial uncertainty can be mutually perpetuating.

3.8 Consolidation

In the second stage, that of consolidation, technology converges to one or a small number of 'dominant designs', exploration shifts to market demand, access to an emerging market (distribution, competition, entry barriers),

efficient production and new appropriate forms of organization, to exploit dominant technical designs. As a result of reduced uncertainty, demand increases and new producers jump on the bandwagon. Related industries and existing distribution channels go along, and adapt, for fear of missing the new boat. An illustration of this, in the development of multi-media, is that publishers finally went along with the digitisation and electronic distribution of text for fear of losing their position (Gilsing & Nooteboom 2002). The new technology/product/market combination develops into a dominant design or 'dominant logic' (Bettis & Prahalad 1995) of organization, including network structure and 'industry recipes' (Spender 1989). There is limited change, in the sense of second order learning and the emphasis is in first order learning, for more efficient exploitation. New entrants exert pressure on price and, for the sake of efficient production increase of scale, the division of labour and associated specializations emerge. Specialization increases the size and stability of the network. The network becomes more closed, with attempts made to block new entry. Knowledge becomes more codified and that enables faster and wider diffusion. Typically, the network expands with more impersonal relations, at a longer distance. An important question is whether the cluster is able to achieve this shift of structure and culture.

3.9 Stagnation or transformation

Depending on the nature and size of effects of scale, increases of scale for the sake of more efficient production are accompanied by horizontal concentration. The growth of demand in the original market stagnates and there is pressure to extend the market. With the entry in new markets, one needs to access wider distribution channels and there is a need to adapt products and organization. This requires knowledge from outside. Experienced Multinational Corporations may be needed to gain access to new markets and outside sources of information. Large firms, utilizing their resources of volume and market reach, may occupy central positions in the transformation of the newly emerging network. This, we suggest, is how Benetton emerged as the central player in the hub of a network. The question is whether the cluster is able to make such a shift to a new network structure. Given our earlier definition of a cluster as having low centrality and hierarchy, the question is whether at this stage we can still speak of a cluster. There is also a shift in forms of governance.

The diffusion of knowledge reduces cognitive distance and increases mutual absorptive capacity. As a result of the increased size of the network, the reduction of cognitive distance, the codification of knowledge and the slow-down of knowledge change, spillover risk increases. Interaction becomes less intensive and shifts from being developmental to being transactional. Interaction becomes less intensive due to the diffusion of knowledge and stabilization of the network, in its dominant design, and the routinization of established practice and the emergence of standards. However, due to a shift towards efficient production and distribution, the size of investments typically increases. With regard to governance, there is less need for relation-specific trust and a basis is created for institution-oriented trust. Reduced uncertainty concerning technology and markets and more codified knowledge creates a basis for more detailed and formal contracts. As a result of the diffusion of knowledge, reduced uncertainty, emerging markets and the adaptation of market structure and institutions, there is both an opportunity and a need to loosen activities from their local embedding. Again, the question is whether the cluster is able to make this shift to different styles of governance.

A potential obstacle in this stage is that the cluster is unable to go along with the codification of knowledge, expansion and transformation of the network, horizontal concentration, loosening from local context, increase of scale and a shift from personal to more formal, impersonal governance. Local embedding and local interests may contribute to such obstacles.

We note, however, that there is no single, universal outcome in terms of network structure, type of ties and governance. The outcome depends on contingencies of the type and extent of markets (e.g. differentiated products or commodities), type of technology, the degree to which activities are systemic or stand-alone, the size and sunkenness of investments, the type of knowledge, extent and type of scale effects, external economies and institutional settings (e.g. relating to competition policy, financial regimes, contracting or trust as a basis for governance). Depending on these contingencies, there are different ways to turn exploration into exploitation. In particular, the outcome depends on the extent to which exploration and exploitation are combined and that depends on the contingencies indicated above. To the extent that exploration and exploitation go together, there will be hybrid forms of networks that combine elements form the present analysis and the one in the previous section. A further analysis of this is beyond the scope of this chapter (see Nooteboom 2000).

The analysis is in line with Boschma and Lambooy's (2002) analysis of developments in Italian industrial districts. They identified the role of MNCs

as 'bridging enterprises', to carry activities into international markets and access outside sources of knowledge. During the workshop, Bjørn Asheim presented examples of Norwegian clusters that had to make a shift from local to global operations (Asheim and Isaksen 2002).

3.10 Break-up and new exploration

Whatever the outcome of the previous stage is, in the subsequent stage experience gathered from expansion in differentiated markets, or invasion of radical innovations from outside, generates new options or needs and this returns us to the first stage. Here, the rigidities of established structures, which offered an advantage for exploitation, become a liability. Emerging novelties cannot achieve their potential under the systemic limitations imposed by existing structures, practices and ways of thinking. An obstacle here is that the cluster or network is locked into its previous success. If the cluster or network is unable to cope with this, it needs to be broken up so that different elements have more scope to adapt, in different ways, to new conditions. Here, a cluster that has not gone the way of integration under the wings of a large MNC, but has managed to maintain its less systemic, more modular nature, with informal governance, is at an advantage since it offers more flexibility for re-configuration. In such cases, it matters which options for reconfiguration are at hand. Here, perhaps, we encounter the notion of 'Jacobs externalities' (Boschma and Lambooy 2002). In urban regions with a large variety of different activities and a rich, varied, complex infrastructure with a wide scope of spillovers, new ideas and activities that become complementary in new ways, there is more scope for new exploration.

3.11 Conclusions

This chapter attempted to contribute to a clarification of the notion of a cluster and its relation to the notions of a value chain/system and a network. A cluster always entails a network with a variety of possible structural features and dimensions of ties. This chapter proposed calling a network a cluster to the extent that it has the following characteristic features: variety of activities, direct and indirect ties between them, including access to markets, shared goals, local embedding, limited hierarchy and largely informal control.
The chapter also proposed that a priority for research lies in cluster dynamics.

Building on a theory of learning and discovery, it proposed an outline of a theory of cluster development, in different stages. It also attempted to specify how the central features of competence, governance, network structure and type and strength of ties change in the process.

It is proposed that typically clusters emerge from local embedding, with a high degree of local, tacit knowledge, weakly formalized ties, dense but also open structures of ties, ties that are strong in terms of frequency and intensity of interaction but weak in the sense that they do not carry heavy investment, have limited durability and maintain flexibility of re-configuration. Governance is largely based on reputation and personal trust. That is one of the reasons that local embedding is needed.

When success of innovation materializes, knowledge becomes more codified, attention shifts to consolidation and efficient production and distribution and the enlargement of market reach. A clear division of labour arises, with fairly stable ties, in less dense structures, with more centrality, as in a hub-and-spoke structure. Governance shifts to more formal, contractual and less personal forms. This, in turn, facilitates market extension. Some disembedding from local conditions is both needed, to enlarge the market reach, and also facilitated by more formal control and codification of knowledge. Here, MNCs may offer both a challenge and an opportunity. One can ask whether in this stage the network still has the characteristics attributed to a cluster, as specified above.

Next, market extension yields new experiences, with new incentives, needs and inspiration for exploration of novel combinations. When these come to fruition, the utilization of their potential may require disintegration of existing network structure to allow for the exploration of novel clusters. This brings us back to the first stage, with a re-embedding in local, more fluid and informal exploration of novel patterns of collaboration. Environments that offer a greater variety of possible components of new structures seem to be at an advantage here ('Jacobs externalities'). However, the mere presence of a variety of networks does not guarantee that opportunities for exploration of novel configurations will be taken. A network in the stage of break-up may not be able to access and 'pry loose' components of a network in the stage of consolidation.

The stages of development indicated above do not yield a universal, inexorable march of logic. What happens, precisely, is highly dependent on contingencies related to the local institutional environment, infrastructure, history, entry and exit conditions and possible roles of multinationals. This theory of cluster development is also still highly speculative. It requires

empirical testing and further study of what variations or deviations form this development path arise under what conditions.

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