Papers in Innovation Studies

Paper no. 2015/46

Understanding Cluster Evolution

Michaela Trippl (michaela.trippl@circle.lu.se)
CIRCLE, Lund University

Markus Grillitsch (markus.grillitsch@circle.lu.se)
CIRCLE, Lund University

Arne Isaksen (arne.isaksen@uia.no)
Department of Working Life and Innovation, University of Agder, Norway

Tanja Sinozic (tanja.sinozic@wu.ac.at)
Institute for Multi-Level Governance and Development,
Vienna University of Economics and Business, Austria

This is a pre-print version of a book chapter accepted for publication in F. Belussi and J-L Hervas-Oliver (Eds) “Unfolding cluster evolution” Routledge

This version: December 2015

Centre for Innovation, Research and Competence in the Learning Economy (CIRCLE)
Lund University
P.O. Box 117, Sölvegatan 16, S-221 00 Lund, SWEDEN
http://www.circle.lu.se/publications

WP 2015/46

Understanding Cluster Evolution

Michaela Trippl, Markus Grillitsch, Arne Isaksen and Tanja Sinozic

Abstract
The past few years have seen an increasing popularity of cluster life cycle approaches. These models, however, suggest a rather deterministic view, are indifferent with respect to context and suffer from biological connotations. This chapter intends to go beyond the cluster life cycle models. We review the literature on industrial districts, innovative milieu and regional innovation systems and investigate how these alternative approaches contribute to the development of a more context-sensitive approach to cluster change. We argue that future research may benefit from developing theoretically relevant categorizations of different cluster types and from carrying out comparative empirical studies.

JEL codes: O10, O30, R10, R50

Keywords: Cluster evolution, cluster life cycle, regional industrial change, regional innovation systems

Understanding Cluster Evolution

Abstract

The past few years have seen an increasing popularity of cluster life cycle approaches. These models, however, suggest a rather deterministic view, are indifferent with respect to context and suffer from biological connotations. This chapter intends to go beyond the cluster life cycle models. We review the literature on industrial districts, innovative milieu and regional innovation systems and investigate how these alternative approaches contribute to the development of a more context-sensitive approach to cluster change. We argue that future research may benefit from developing theoretically relevant categorizations of different cluster types and from carrying out comparative empirical studies.

Keywords: Cluster evolution, cluster life cycle, regional industrial change, regional innovation systems

JEL Codes: O10, O30, R10, R50

1 Introduction

The past two decades have witnessed an enormous scholarly and policy interest in regional clusters. A large body of work has focused attention on explaining why clusters exist and what the main characteristics of "functioning" or fully developed clusters are. Whilst there is a rich literature on existing clusters, relatively little has been said so far about how clusters emerge, change and develop over time. There is, however, a growing recognition of the need to develop dynamic perspectives to gain insights into long-term cluster evolution and change (see, for instance, Bergman 2008; Menzel & Fornahl 2010).

Popular approaches in this emerging field of research are different variants of the cluster life cycle (CLC) approach. In particular the new generation of the CLC models has enhanced knowledge of crucial factors that may trigger the rise and further development of clusters. These approaches, however, suffer from several shortcomings, most notably from rather deterministic views that preclude one from capturing the complexity and variety of cluster transformation that are evident from empirically grounded contextualised studies.

The aim of this chapter is to go beyond the CLC concepts and to contribute to a better understanding of the context specific nature of cluster transformation. Based on an analysis of different strands of literature, alternative and possibly more convincing explanations of cluster change are explored. We provide a critique of the CLC approach by use of elements from the literature on industrial districts, innovative milieu and regional innovation systems.

The remainder of the chapter is organized as follows. Chapter 2 introduces the CLC concept. We discuss the conceptual arguments made by its main protagonists and elaborate on the limitations that surround this approach. In Chapter 3 we review alternative schools of thought

that have contributed – albeit under different labels – to cluster research. We analyse the literature on industrial districts, innovative milieus and regional innovation systems to find out whether these strands of literature can provide more promising insights into how clusters develop over time. Finally, Section 4 outlines the contours of a context-sensitive approach to cluster change.

2 Review of the cluster life cycle approach

With the call for a more dynamic view on clusters, the CLC approach has recently gained increasing attention. The approach, however, is not new (for a review of the CLC literature, see Bergman 2008). It departs from the presumption that regional clusters go through different phases, often described as emergence, growth, sustainment, decline, and possibly renewal. Various approaches to cluster life cycles exist, which differ in particular in their explanation of how new clusters emerge, and in the driving forces that explain the transition of clusters between the phases (Bergman 2008). In this section, we will focus on the currently most influential new CLC approaches of Menzel & Fornahl (2010), Ter Wal & Boschma (2011) and Martin & Sunley (2011).

The new CLC approaches have the merit of taking up recent developments in the literature on evolutionary economic geography, highlighting the importance of firm heterogeneity, related variety, the evolution of networks, and path-dependency for regional industrial change. The first model of Menzel & Fornahl (2010) focuses on firm heterogeneity and technological convergence or divergence through learning processes. Depending on these processes, they also acknowledge the possibility of alternative development paths. The contribution of Ter Wal & Boschma (2011) also underlines the importance of firm heterogeneity. In addition,

they claim that clusters "co-evolve with the industry to which they adhere, with the (variety of) capabilities of firms in that industry, and with the industry-wide knowledge network of which they are part." (p. 929). The paper of Martin & Sunley (2011) differs as cluster change is conceptualised through an adaptive cycle model, which does not privilege a specific development trajectory.

Menzel & Fornahl (2010) propose a clear distinction between cluster firms, firms in the same industry located elsewhere, and firms in other industries but located in the same region. While appreciating the role of interactions between these different types of firms, the institutional context and the industry life cycle, it is argued that firm heterogeneity and localised learning processes are the central factors explaining cluster change. Hence, the authors relate to recent work in evolutionary economic geography emphasising the importance of variety, i.e. firm heterogeneity for innovation and economic growth. What is more, their model exhibits parallels with the debate on related variety and proximity (Boschma 2005; Frenken et al. 2007). Menzel & Fornahl (2010) suggest that the development of technological relatedness between firms is a precondition for the emergence of a cluster while heterogeneity is considered as crucial source for the extension or renewal of development trajectories. Clusters begin "… in those regions where the knowledge bases of companies converge around technological focal points" (p. 231). Technological convergence underlying the momentum of cluster formation is shaped by, amongst other factors, interactive learning processes between heterogeneous firms in geographic proximity to one another. Firm heterogeneity can be increased through learning with non-cluster firms both locally and globally. This may bring in new knowledge to the cluster, shifting its thematic boundaries (Menzel & Fornahl 2010).

The first cluster phase if characterised by spin-offs, a small number of technologically diverse companies, a supportive science and skills base, and policy support "(…) which give the emerging cluster the potential to reach a critical mass" (Menzel & Fornahl 2010, p. 225). In the second stage of the CLC, firms grow both in number and in size. The cluster becomes increasingly specialised, causing a more homogeneous knowledge base, a clearer cluster structure, and comes closer to the technological frontier. In the third stage, maturity, clusters are relatively stable and have dense firm networks. In this stage, clusters risk becoming homogenous, over-reliant on a single technological path, and thus locked-in and vulnerable to decline because its capacities for renewal have been exhausted. In such conditions, the cluster reaches its fourth stage of development, one of decline, its main features being firm closures, failures, and lay-offs. In such conditions, declining clusters can be revitalised by an increase in technological heterogeneity via, for example, firms, skills or resources external to the cluster. Menzel & Fornahl's model suggests that localised learning dynamics and firm heterogeneity propel clusters through life-cycles. Despite this dominant trajectory, the authors also open up for alternative trajectories. For instance, without technological convergence in the emergence stage, a cluster may never reach the growth stage. Also, by introducing heterogeneity in later stages, clusters can continuously renew themselves and don't necessarily need to decline. In sum, "clusters display long-term growth if they are able to maintain their diversity" (Menzel & Fornahl 2010, p. 218).

Ter Wal & Boschma (2011) propose a framework where clusters co-evolve with firm capabilities, industry life cycles and networks. The authors emphasise the importance of variety as regards firm capabilities, which resonates well with the model introduced by Menzel & Fornahl (2010). In addition, the framework of Ter Wal & Boschma (2011) elaborates on the effects of networks for the evolution of clusters. However, the debate on

how industry life cycles materialise in space dates back to earlier literature such as Storper & Walker's (1989) theory of geographical industrialization.

Ter Wal & Boschma (2011) explain cluster evolution as interplay between cluster imminent factors (firm capacities and networks) and the evolution of the industry. Due to the high degree of uncertainty at early stages of an industry, a large variety of firm competences exist and networks are unstable. The emergence of clusters is initiated through pioneering firms introducing radical innovations. However, at this stage, it is unclear which will be the dominant designs and successful firms creating a window of locational opportunity (Storper & Walker 1989). The probability for the raise of a new cluster, however depends on regional branching processes, regional assets such as a qualified labour force and infrastructure, as well as new combinations facilitated through diversity. As clusters grow, Ter Wal & Boschma (2011) argue that several forces lead to stable core-periphery network patterns. These forces include the advantageous network position of pioneers, the higher likelihood of firms in weaker positions to exit the industry, and the importance of previously successful collaborations. The high degree of tacit knowledge at this stage makes physical proximity, and social capital such as trust important, thus clustering becomes a distinct advantage for firms. Maturity relates to a saturation of markets and technological development potential leading to increasingly incremental and process innovations. Economies of scale and cost reduction increasingly matter leading to a large number of firm exits. Being located at the core of the network, which often coincides with the location of the main clusters, facilitates survival. The endurance and stability of networks and clusters can have distinct disadvantages in the stage of maturity because firm variety decreases, which may lead to cognitive lock-in, and the increasing codification of knowledge reduces the need for geographic proximity. Two possibilities, industry decline or renewal, are provided in the fourth stage of development. The

cluster declines if no novel innovations are introduced. A new cycle may be started if cluster firms succeed in generating a new technological breakthrough. However, similar as in the introductory stage, such technological breakthroughs will often be generated outside the cluster leading to significant changes in the network structure. The degree to which clusters will emerge or renew themselves is partially uncertain because of the unpredictable nature of innovation (Ter Wal & Boschma 2011).

Both Ter Wal & Boschma's (2011) and Menzel & Fornahl's (2010) approaches argue for a life cycle model of cluster change underpinned by evolutionary processes, and create important theoretical linkages between previously disparate bodies of literature such as evolutionary economic geography, industrial and technological dynamics and cluster change. The combination of life cycle models with evolutionary processes is both a strength and a weakness of the two approaches. For example, conceptualising cluster change occurring along stages makes the search for outcome variables easy (e.g. firm entry during emergence, firm exit during decline). The combination with neo-Schumpeterian evolutionary concepts such as firm capabilities, with sectoral change specificities (Klepper 1997) adds both depth and breadth to understanding the processes occurring within stages that lead to cluster change. However, it remains unclear how long each stage is supposed to last and why they should occur consequentially. It is likely that clusters can avoid steep falls in growth by institutional mechanisms such as labour laws and investment in research. Without an idea of how long the individual stages are, it becomes difficult to develop policy instruments to support the individual cluster stages, or indeed to define at which stage a cluster is at. It must be noted that both Menzel & Fornahl (2010) and Ter Wal & Boschma (2011) emphasise the need for empirical testing, which may yield more substantive analytical arguments for extension or critique of the theoretical frameworks.

Compared to the previously reviewed models, Martin & Sunley (2011) introduce a framework of cluster evolution, which identifies besides the typical life cycle trajectory several other potential cluster trajectories. This is in line with the development of the path-dependence theory in evolutionary economic geography, where path-dependence does not imply historical determinism but is seen in relation to mechanisms propelling path creation and path destruction (Martin 2010; Simmie 2012). Following this logic, Martin & Sunley (2011) criticise the deterministic logic of life cycle approaches, which carry biological connotations and imply "some sort of 'aging' process. But in what sense can clusters be thought of having 'lives' or 'ageing' or passing through 'life stages'?" (p. 1300). In their view, the trajectories of clusters are unpredictable, mainly because they consist of agents who learn, interact and respond to their perceptions about the current state and future development within the cluster and their environment. The authors propose to think about clusters as complex adaptive systems and apply an adaptive cycle model. Comparable to traditional life cycle approaches, the adaptive cycle model describes four phases: i) cluster emergence, renewal or replacement, ii) cluster growth, iii) cluster maturation, and iv) cluster decline. In contrast to the traditional approaches, the adaptive system model allows for a variety of development trajectories. In their slightly modified version, Martin & Sunley (2011) identify six possible evolutionary trajectories. One follows the typical life cycle of emergence, growth, maturation, decline and eventual replacement. The notion of replacement strongly builds on the idea that existing resources are released and brought to new use. However, clusters do not necessarily need to move from a growth to maturity stage. Particularly clusters with strengths in generic or general-purpose technologies, usually associated with high-tech industries, may continuously innovate and mutate. The heterogeneity of firms remains high due to on-going intensive innovation activities. This is often linked to geographically open knowledge networks, i.e.

while there might be a high connectedness within the cluster, firms have established interregional, sometimes global linkages, a feature that has been observed for high-tech clusters. Also, the future technological paths remain uncertain. This in turn requires a strong endowment with venture capital so that firms can embark in uncertain, radical innovation activities. Such clusters keep a high degree of resilience. In addition, Martin & Sunley (2011) illustrate that clusters may for instance fail to grow, be replaced and disappear, or stabilise after the growth phase even in mature industries.

3 Alternative Approaches to Cluster Change

The CLC approaches suggest that cluster evolution should be seen as a sequence of prescribed stages. In this section we discuss alternative concepts, i.e., the literature on industrial districts, innovative milieus and regional innovation systems. These approaches share the conviction that there is more than one potential development path of cluster evolution. They thus offer a less deterministic view of cluster change and a more flexible and open framework to capture the variety of paths that clusters can follow.

3.1 Industrial district approach

The industrial district (ID) approach has its origins in Alfred Marshall's writings on the rise of localized industries and their long-term anchoring in districts. Marshall (1920) argued that the *initial localization* of industries might have many sources, ranging from the availability of raw material, demand for goods of high quality or the immigration of people with specialized skills. Once an industry is spatially concentrated in a particular locality, a set of positive

external economies of scale keeps it in place, including knowledge spillovers, the rise of supplier industries, and labour market effects. Marshall also raised awareness to the potential dangers of such settings. He considered IDs that are dependent on one industry only as being extremely vulnerable, pointing to the risk of *crisis and decline* in case of changing context conditions such as, for instance, a fall in demand for its products or changes in technology.

Marshall's ideas were revitalized in the 1980s by a group of Italian researchers, who studied small-firm clusters operating in mature sectors (textiles, leather goods, furniture) in the Third Italy. This literature has enlarged one's understanding of the role of exogenous and endogenous factors in the rise of clusters. Changing external context conditions are viewed as essential for the *emergence and growth* of Italian IDs in the 1960s and 1970s. The end of the golden age of mass production, higher income levels, increasing demand for quality products and technological innovations provided a favourable context for the rise of IDs. The early growth of IDs, however, has also endogenous sources, notably the existence of a set of social-cultural factors that are territorially specific and deeply rooted in the history of Third Italy's regions (Isaksen 2011). These include long-standing traditions and competences in craft work, entrepreneurship and management of small firms, the prevalence of strong local identity and solidarity (providing the social underpinnings of local collaboration), and a tradition of family firms which are flexible towards market changes. Until the 1990s, many Italian IDs showed a dynamic development.

The focus of recent contributions to the ID literature is primarily on major *transformation processes* that many Italian IDs are undergoing since the dynamic period until the 1990s. Several authors argue that these processes are mainly the outcome of changes in external context conditions (Rabellotti et al. 2009), particularly the spread of radical technological

innovation, global changes in production systems and the internationalization of the economy. Others scholars put more emphasis on endogenous factors, highlighting the erosion of factors that were critically important for IDs past success (Bianchi 1998).

Studies of Italian IDs have identified a variety of adjustment strategies of IDs and point to the existence of different development patterns (Rabellotti et al. 2009). Some IDs disappeared as a result of crises in their area of specialization (e.g., textile districts in Lombardy and Veneto). In most cases, these districts were specialized in low cost production and failed to compete successfully with manufacturers in newly emerging countries. In other IDs new specializations emerged (quality upgrading within old sectors, rise of new sectors, increasing importance of the service sector). Some districts do no longer show one of the key features of an ID, that is, the predominance of small firms. A process of "hierarchization" can be observed; leading medium-sized companies and groups of firms (Randelli & Boschma 2012) are now the most dynamic agents and key driving forces of structural changes (Rabellotti et. al 2009). A large body of work (see Belussi 2011 for a review) has dealt with new international strategies of ID firms. Increasing outsourcing of intermediate activities abroad and integration into global production networks have undermined one of the foundations of the past economic success of Italian districts, that is, deep specialization along the production chain confined within the ID's geographical boundaries. IDs have transformed from previously relatively closed systems into more open ones as IDs are becoming increasingly integrated into innovation systems at higher spatial scales (Belussi 2011).

To summarize, the ID literature offers valuable insights into the genesis, decline and transformation of clusters. A key finding is that Italian IDs have not followed one development path but many (Belussi 2011; Rabellotti et al. 2009). Furthermore, the literature

points to the complexity of changes that can be observed in the course of cluster evolution, ranging from changes in the economic specialization, the rise of new actors (emergence of business groups and leading firms that act as knowledge gatekeepers, new ethnic firms), changes in the composition of cluster actors (number and size of firms), new firms strategies, new division of labour among firms, and a reconfiguration of internal and external economic and knowledge linkages. The Italian ID literature seems particularly useful for understanding change processes of clusters made up of small firms operating in traditional industries. One might, however, criticize that this literature is mainly empirically orientated, offering little in terms of conceptual progress as regards cluster evolution.

3.2 Innovative milieu concept

While there is no uniform definition for the innovative milieu concept, which was developed in the mid 1980s, one of its main advocates, Roberto Camagni (1995, p. 320) describes milieu as "the set of relationships that occur within a given geographical area that bring unity to a production system, economic actors, and an industrial culture, that generate a localized dynamic process of collective learning and that act as an uncertainty-reducing mechanism in the innovation process."

A milieu, therefore, consists of formal and informal networks and interdependencies between economic actors in a region. This implies that actors are regionally embedded and, over time, build reputation, trust and shared expectations, underpinning knowledge exchange and facilitating regional collective learning. Collective learning is strengthened through joint projects and regional labour mobility. Consequently, collective learning brings about a shared knowledge base about technological and organisational solutions, usually in a specialized

field (e.g. related to a technology or sector). In such a specialised field, strong regional input-output relationships are seen to be the core of a local production system (Maillat 1998).

The concept of innovative milieu is relevant for this chapter because it explicitly deals with change and evolutionary processes. “A milieu is not unchanging, it is not defined a priori and once and for all. On the contrary, it constitutes a dynamic complex which in the course of time has had to change and evolve by means of a continuous process of resource creation, innovation and adaptation to external constraints” (Maillat et al. 1996).

Regional change and evolution are often described as a perpetual process of rupture and filiation, or break and continuity (Camagni 1995; Crevoisier 2004; Maillat 1998). The assumption is that local production systems and milieus have a tendency to reproduce themselves and thus exhibit a certain degree of inertia and continuity. Change results from the dynamic interplay between the existing milieu and local production system, capturing turbulences in the market and technological environment and collective learning processes based on the knowledge, skills, networks, and expectations developed in the past. For such change processes, external linkages play an important role in identifying turbulences in the environment and in providing inputs to collective learning. Collective learning and innovation are required to maintain the compatibility with the technical and market environment. In this way, collective learning leads to modifications of the milieu and the local production system, which are the new starting points for future changes. Finally, in order for an innovative milieu to prevail, integration processes are necessary to maintain its internal coherence. In the framing of change processes, some evolutionary thoughts such as path-dependencies can be identified (Crevoisier 2004; Maillat 1998).

The milieu concept also distinguishes factors that influence the above mentioned change processes. Network linkages outside the region are such a factor and comprise for instance strategic alliances, or commercialization agreements through which "external energy" for innovation processes can be captured (Camagni 1995). The interaction logic within the milieu is another important factor. It refers to the capacity to interact and develop a collective response to external turbulences. This usually requires a long-term business rationale based on innovation as opposed to a short-term perspective based on rationalisation and cost-cutting. Also, it depends on whether regional consensus and shared visions exist. Ideally, by mobilising collective learning processes, the regional structure, organisation and technologies are upgraded and region-specific resources created. In this process, leading actors that drive such processes play an important role (Maillat 1998; Maillat et al. 1996).

Research on innovative milieus has strongly focused on innovative growth regions and high-tech clusters, although there are also contributions dealing with the revitalisation of old industrial regions and conservative milieus. In summary, the milieu concept emphasises the role of innovation and regional adaptation to (external) changes in the technological and market conditions. Change is thought to occur through perpetual processes of rupture and continuity. However, it remains relatively vague as regards why, how and under which conditions key processes such as maintaining compatibility with the external environment or maintaining internal coherence lead to cluster growth or renewal and when they might fail. Also, the milieu concept has been criticized for a lack of clarity as regards terminology and for the difficulty to objectively measure and compare milieus of different regions.

3.3 Regional Innovation Systems

The ID concept and the milieu approach are key theoretical predecessors of the more recent regional innovation system (RIS) concept (Asheim et al. 2011). The RIS literature (Asheim 2007; Cooke 1992, 2001) devotes attention to the companies, cluster structures, knowledge providers and the institutional set-up of a region, as well as to knowledge links within the region and to the external world. Like other innovation systems variants, the RIS approach conceptualizes innovation as an evolutionary, non-linear and interactive process. The region is seen as a crucial level at which innovation is generated through knowledge linkages, clusters and the cross-fertilising effects of research organisations (Asheim & Gertler 2005).

RISs come in many shapes. Cooke (2004) distinguishes between entrepreneurial and institutional RISs and claims that the former offer excellent conditions for the development of high-tech clusters, whilst the latter provide a fertile ground for the evolution of traditional ones. Tödtling & Trippl (2005) draw a distinction between organizationally thin, fragmented and locked-in RIS and argue that each of these configurations is associated with distinct barriers to cluster development. These typologies are useful for analysing how the evolution of a cluster might be influenced by the RIS in which it is embedded. Indeed, there are strong reasons to assume that cluster change differs depending on the characteristics of the RIS.

The relation between RISs and cluster evolution is complex. According to the RIS approach, clusters form an integral part of RISs. The emergence, growth, maturity, decline and possibly renewal of clusters can, thus, only be understood if the specificities of the knowledge infrastructure, institutional set up, cultural aspects and policy actions of a particular region are considered. Several studies suggest that the *rise and early development* of clusters is shaped by the configuration of the RIS. The emergence of clusters is likely to follow different routes,

depending on historically evolved competences and pre-existing RIS structures. Conceptual and empirical work on the rise of high tech clusters shows that RISs that already host dynamic high tech clusters provide favourable conditions for the emergence of new ones, even if these newly emerging clusters are different from those developed earlier. Such RISs offer essential conditions, such as excellent research institutes, venture capitalists, a pool of highly skilled mobile workers and dense communication networks (see, for instance, Prevezer 2001). RISs that are poorly endowed with such structures, experiences, and knowledge assets are likely to follow different paths. The rise of new (high-tech) clusters in such regions is less a spontaneous phenomenon but depend more on the inflow of external knowledge, expertise and market intelligence and a stronger role of policy. In addition, new cluster formation in such regions is inextricably linked to a transformation of the RIS that becomes manifest in the creation of a variety of new organisations, processes of institutional (un)learning and socio-cultural shifts.

Then there are also scholarly contributions that deal with the *renewal of traditional clusters*. Much of this work is focused on old industrial regions, emphasizing a strong relation between the rejuvenation of mature clusters and prevailing RIS characteristics including their transformative capacities. It is argued that successful revitalisation of old clusters is influenced by the configuration of the RIS, such asstructures, activities and orientation of knowledge providers, the role of regional policy agencies, the socio-institutional fabric, as well as the extent and nature of links. The presence or absence of favourable RIS structures and changes (transformation of the knowledge infrastructure, institutional innovations, policy-learning processes) can make a difference (Trippl & Otto 2009).

To summarize, the RIS literature emphasizes that cluster development and change cannot be

assessed independently from its context (i.e. the overall RIS). RISs can facilitate or hamper the development and change of clusters. Both the emergence of new clusters and the revitalisation of old ones are likely to show a different pattern, depending on the RIS in which they are embedded. Existing RIS structures and their transformation have an influence on how clusters change and which mechanisms of change dominate. Cluster evolution is thus a context-specific phenomenon that varies strongly between different types of RIS. However, the RIS approach is criticised for being primarily concerned with structural elements of the innovation system (Uyarra 2011). The importance of actors, such as entrepreneurs in universities and firms, for innovation performance are much less considered. Likewise, the role of uneven power among actors when it comes to prioritising tasks and resources in organisations in the innovation system seems to be absent in RIS studies (Uyarra 2011). Furthermore, RIS studies have often been snapshots focusing on the characteristics, and strengths and weaknesses, of particular well developed systems, while the historical development of the systems is less reflected upon (Doloreux & Parto 2005).

4 Conclusions: Towards a Context-Sensitive Approach to Cluster Change

This chapter sought to contribute to the development of a dynamic perspective in cluster research. We have argued that the CLC approaches – which have gained increasing visibility in recent reflections on cluster dynamics – are not uncontested. They provide a rather deterministic view, are indifferent with regard to regional and industrial context conditions as they aim to attain one general development path for cluster development, and they suffer from biological connotations. We reviewed the literature on industrial districts, innovative milieus and regional innovation systems and examined whether these approaches allow for alternative views and a more profound understanding of how clusters evolve and change.

The review of the approaches has uncovered essential dissimilarities in their explanations of cluster change. An important difference "dividing" the approaches concerns the dimensions of cluster dynamics that are highlighted. CLC approaches focus primarily on the characteristics and dynamics of firms, their capabilities and networks. The milieu approach, in contrast, emphasises socio-cultural aspects that shape clusters' internal interaction modes. Hence, it values institutional aspects of place-specificity higher than the CLC approaches. The ID concept stresses characteristics of the industry structure and also highlights the role of socio-cultural factors. The RIS approach emphasizes the role of the region's organisational and institutional configurations, its overall industrial structure and knowledge exploration capacity as well as policy actions. It is argued that these structural features shape cluster dynamics. All approaches discussed in this chapter, thus, illuminate certain aspects of cluster change. Each of them highlights particular dimensions but pays less attention to others.

Then, as shown in section 3, the alternative approaches stress that clusters may not necessarily follow one path but many, i.e. they follow multiple path dependencies (Belussi & Sedita 2009). This highlights the need to carry out more empirical studies in the future that put cluster evolution into a comparative perspective. A possible route of further research is to distinguish between types of clusters and elaborate on their specific path dependent development. Whilst not repeating the deterministic understanding in some CLC approaches, we nonetheless assume that different types of clusters, for example high-tech clusters drawing on scientific advances and traditional clusters based mostly on experience based competence, have quite different driving forces of change. The search for one overarching theory of the emergence and evolution of clusters may therefore be misleading. It seems to be more promising to develop theoretical relevant categorizations of different types of clusters and

examine the characteristics of their historical developments. This understanding implies that one task for further research on cluster evolution would be conceptual and empirical studies to outline typical, possible development paths for different types of clusters.

What are then distinguishing factors to identify clusters that follow comparable development paths? Ter Wal & Boschma (2011) focus on industry, firm capabilities and firm networks as key concepts to explain the development of clusters. Clusters in specific industries are affected by general market and technological development within these industries. Industrial classifications may however include diverse activities. Different parts of industries may display different development dynamics, and clusters in similar industries may also reveal quite different path development. Belussi & Sedita (2009) demonstrate that firms in one footwear district in Italy diversified their products, which attracted some big luxery brands to the district, while firms in another Italian footwear district carried out a cost-led strategy and outsourced production to low-cost countries. This demonstrates that no one-to-one relationship between industry and cluster life cycles exists. Such a lesson can also be drawn from the empirical analyses of firms' innovation processes and strategies in 13 European countries by Srholec & Verspagen (2012). These authors demonstrate that firms in individual industrial sectors use very different innovation strategies, e.g. with regard to inputs to and results of innovation activity. Most of the difference in firms' innovation strategy includes heterogeneity among firms within sectors; 'heterogeneity between firms will result from the process of strategy formation at the firm level' (Srholec & Verspagen 2012, p. 1248). This implies that industrial sectors do not display much about how clusters develop through their life cycles simply because no specific innovation strategies are prominent in individual sectors.

The empirically based categorisation of firms' innovation strategies by Srholec & Verspagen (2012) accords with the more analytical approaches of differentiated knowledge bases (Asheim et al., 2011) and innovation modes (Jensen et al. 2007). These approaches categorise firms based on their critical knowledge input in innovation processes and on how firms organise and conduct innovation activity. Isaksen & Karlsen (2012) demonstrate that firms within one regional cluster in mechanical engineering use different innovation modes, which indicates that innovation mode is more of a firm specific activity than the characteristic of this specific cluster or industy. Other research demonstrates likewise that clusters dominated by analytical knowledge build upon, and develop, other formal and informal institutional structures than more traditional clusters based on synthetic knowledge (Asheim & Coenen 2005). For example, entrepreneurs have very different education and experience in the two types of clusters, firms are recruiting from different segments of the labour market, and firms draw on different kinds of external knowledge sources and develop new knowledge in different ways. Based on such arguments one should expect that clusters dominated by, for example, firms with a specific innovation mode share a number of common challenges and display some commonalities in their evolution.

The distinguishing factors to identify specific development paths of clusters have so far been studied at the industry and firm level. While these factors are vital in analysing cluster evolution, our review of theoretical frameworks points also to the importance of the existing wider RIS structure for how clusters emerge and develop. The industrial district and innovative milieu approaches, in particular, also point to the importance of place-specific, social-cultural and institutional aspects for cluster evolution. Cusmano et al. (2015: 63) thus maintain that the entrepreneurial process in an Italian industrial district is largely influenced by "Marshallian externalities, such as knowledge spillovers and the supply of 'collective

goods' at the territorial level". 'Localized socio-institutional environments built over time in a path dependent way' (Strambach & Klement 2012, p. 1845) shape how firms use and create knowledge and innovate. The recent contributions on cluster evolution, however, hardly reflect on these context-specific factors as possible explanations why clusters follow different development paths (Trippl et al. 2015).

Based on the above discussion the identification of diverse development paths of clusters should include a mix of macro factors (such as type of industry and industry life cycles), meso factors (the RIS structure including place-specific institutional set-ups), and micro factors (firms' knowledge bases and innovation modes). The relative importance of each factor and the mix of factors may differ among regions, but cluster evolution results from the dynamic interplay between macro, meso and micro factors. A similar multiscalar approach to analyses of cluster development is proposed by Santner and Fornahl (2014). Such an approach allows for a variety of potential path developments. Our contribution has been to elaborate analytically on the key factors in question. We suggest that future research should aim at exploring why and how the interplay of these factors affects cluster evolution in specific contexts, and consequently at identifying commonalities that allow grouping clusters according to the main factors driving their evolution. Hence, we also contribute by laying a sound foundation for comparative studies of cluster evolution and to make approaches to multiple path development of clusters theoretically informed so that these do not simply become empirically based exercises.

References

Asheim, B. (2007) Differentiated knowledge bases and varieties of regional innovation systems, *Innovation*, 20, pp. 223-241.

Asheim, B. & Coenen, L.(2005), Knowledge bases and regional innovation systems: Comparing Nordic clusters, *Research Policy,* 34 (8), pp. 1173-1190.

Asheim, B. & Gertler, M. (2005), The Geography of Innovation: Regional Innovation Systems. In: J. Fagerberg, D. Mowery & R. Nelson (Eds.) *The Oxford Handbook of Innovation*, pp. 291-317 (Oxford: Oxford University Press)

Asheim, B., Boschma, R. & Cooke, P. (2011) Constructing Regional Advantage: Platform Policies Based on Related Variety and Differentiated Knowledge Bases, *Regional Studies*, 45(7), pp. 893-904.

Belussi, F. (2011), The new Marshallian districts and their process of internationalization, in P. Cooke, B. Asheim, R. Boschma, R. Martin, D. Schwartz & F. Tödtling (Eds.) *Handbook of Regional Innovation and Growth*, pp. 90-99 (Cheltenham: Edward Elgar)

Belussi, F. & Sedita, S. (2009) Life cycle vs. multiple path dependency in industrial districts, *European Planning Studies*, 17(4), pp. 505-528.

Bergman, E. (2008) Cluster life-cycles: An Emerging Synthesis, in C. Karlsson (Ed.) *Handbook of Research on Cluster Theory*, pp. 114-132. (Cheltenham, Edward Elgar)

Bianchi, G. (1998) Requiem for the Third Italy? Rise and Fall of a too successful concept, *Entrepreneurship & Regional Development*, 10(2), pp. 93-116.

Boschma, R. (2005) Proximity and Innovation: A Critical Assessment, *Regional Studies*, 39, (1), pp. 61-75.

Camagni, R. (1995) The concept of innovative milieu and its relevance for public policies in European lagging regions, *Papers in Regional Science*, 74(4), pp. 317-340.

Cooke, P. (1992) Regional innovation systems: competitive regulation in the new Europe, *Geoforum*, 23, pp. 365–382.

Cooke, P. (2001) Regional innovation systems, clusters and the knowledge economy, *Industrial & Corporate Change*, 10, pp. 945–974.

Cooke, P. (2004) Integrating global knowledge flows for generative growth in Scotland: life science as a knowledge economy exemplar, in J. Potter (Ed.) *Inward investment, entrepreneurship and knowledge flows in Scotland - international comparisons*, pp. 73-96 (Paris: OECD)

Crevoisier, O. (2004) The Innovative Milieus Approach: Toward a Territorialized Understanding of the Economy., *Economic Geography*, 80(4), pp. 367-379.

Cusmano, L., Morrison, A., & Pandolfo, E. (2015) Spin-off and clustering: a return to the Marshallian district. *Cambridge Journal of Economics, 39*, pp. 49-66.

Doloreux, D., & Parto, S. (2005). Regional innovation systems: Current discourse and unresolved issues. *Technology in Society*, 27, pp. 133-153.

Frenken, K., Van Ort, F. & Verburg, T. (2007) Related Variety, Unrelated Variety and Regional Economic Growth, *Regional Studies*, 41(5), pp. 685-697.

Isaksen, A. (2011) Cluster evolution in P. Cooke, B. Asheim, R. Martin, D. Schwartz & F. Tödtling (Eds.) *Handbook of Regional Innovation and Growth*, pp. 293-302 (Cheltenham: Edward Elgar) .

Isaksen, A. & Karlsen, J. (2012) What is regional in regional clusters? The case of the globally oriented oil and gas cluster in Agder, Norway, *Industry and Innovation*, 19(3), pp. 249-263.

Jensen, M. B., Johnson, B., Lorenz, E. & Lundvall, B. (2007) Forms of knowledge and modes of innovation, *Research Policy*, 36(5), pp. 680-693.

Klepper, S. (1997) Industry life cycles, *Industrial and Corporate Change*, 6, pp. 145-181.

Maillat, D 1998, 'From the industrial district to the innovative milieu: Contribution to an analysis of territorialised productive organisations', *Recherches Economiques de Louvain*, vol. 61, no. 1, pp. 111-129.

Maillat, D., Léchot, G., Lecoq, B. & Pfister, M. (1996) Comparative analysis of the structural development of milieu: The example of the watch industry in the Swizz and French Jura Arc,

Working Paper 96-07, Institut de recherches économiques et regionals, Université de Neuchatel, Neuchatel.

Marshall, A. (1920) *Principles of Economics* (8th Edition) (London: Macmillan).

Martin, R. (2010) Roepke Lecture in Economic Geography - Rethinking Regional Path Dependence: Beyond Lock-in to Evolution' *Economic Geography*, 86(1), pp. 179-192.

Martin, R. & Sunley, P. (2011) Conceptualizing Cluster Evolution: Beyond the Life Cycle Model?, *Regional Studies*, 45(10), pp. 1299-1318.

Menzel, M-P. & Fornahl, D. (2010) Cluster life cycles—dimensions and rationales of cluster evolution, *Industrial and Corporate Change*, 19(1), pp. 205-238.

Prevezer, M. (2001) Ingredients in the early development of the U.S. biotechnology industry, *Small Business Economics*, 17(1/2), pp. 17-29.

Storper, M. & Walker, R. (1989) *The Capitalist Imperative. Territory, Technology, and Industrial Growth*, (New York: Basil Blackwell).

Rabellotti, R., Carabelli, A. & Hirsch G. (2009), Italian Industrial Districts on the Move: Where are They Going?, *European Planning Studies*, 17(1), pp. 19-41.

Randelli, F, & Boschma, R. (2012), Dynamics of Industrial Districts and Business Groups: The Case of the Marche Region, *European Planning Studies*, 20(12), pp. 1961-1974.

Santner, D., & Fornahl, D. (2014) From here, from there, and from beyond: endogenous and exogenous factors triggering change along the cluster life cycle in a multi-scalar environment. *Working papers on Innovation and Space #02.14.* Philipps Universitet Marburg.

Simmie, J. (2012) Path Dependence and New Technological Path Creation in the Danish Wind Power Industry, *European Planning Studies*, 20 (5), pp. 753-772.

Srholec, M. & Verspagen, B. (2012) The Voyage of the Beagle into Innovation: Explorations on Heterogeneity, Selection and Sectors, *Industrial and Corporate Change*, 21(5), pp. 1221-1253.

Strambach, S. & Klement, B. (2012), Cumulative and Combinatorial Micro-dynamics of Knowledge: The Role of Space and Place in Knowledge Integration, *European Planning Studies*, 20(11), pp. 1843-1866.

Ter Wal, A. & Boschma, R. (2011), Co-evolution of Firms, Industries and Networks in Space, *Regional Studies*, 45(7), pp. 919-933.

Tödtling, F. & Trippl, M. (2005) One size fits all? Towards a differentiated regional innovation policy approach, *Research Policy*, 34(8), pp. 1203-1219.

Trippl, M. & Otto, A. (2009), How to turn the fate of old industrial areas: a comparison of cluster- based renewal processes in Styria and the Saarland, *Environment and Planning A*, 41(5), pp. 1217-1233.

Trippl, M., Grillitsch, M., Isaksen, A. & Sinozic, T. (2015) Perspectives on cluster evolution: critical review and future research issues, *European Planning Studies*, 23(10), pp. 2028-2044.

Uyarra, E. (2011). Regional Innovation Systems Revisited: Networks, Institutions, Policy and Complexity, in T. Herrschel, & P. Tallberg (Eds.), *The Role of Regions? Networks, Svale, Territory*, pp. 169-193 (Malmø: Region Skåne).