

# The Story of Cluster as a Cross-Boundary Concept: From Local Development to Management Studies



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**Abstract** The chapter explores in an original manner the evolutionary trajectories of the cluster concept over time through the application of analytical tools coming from the realm of bibliometric analysis and social network analysis. In particular, we build on a previous work (Lazzeretti et al. *J Econ Geogr* 14(1), 21–43; 2014) to observe the evolution of the cluster literature alongside two main dimensions: (1) publication outlets and (2) paper keywords. Our analysis confirms the interdisciplinary character of the cluster concept, with the presence of publication outlets from different research fields. However, the contribution of management and innovation studies increases over time. The longitudinal analysis of the keywords confirms this trend and reveals that the cluster literature is evolving from economic and sociological-related issues to management-related topics, where innovation and firm performance are the leading issues.

**Keywords** Industrial cluster · Industrial district · Bibliometric analysis · Social network analysis · Keyword analysis

## 1 Introduction

The chapter contributes to previous work on the foundations and the development of the cluster concept by introducing a new perspective of analysis, which is oriented to pinpoint the thematic move from the origin to the last phases of development of a mature, well-known, and widespread concept such as that of cluster. The contribution, which is theoretically driven, explores in an original manner the evolutionary trajectories of the cluster concept over time through the application of analytical tools coming from the realm of bibliometric analysis and social network analysis. In

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particular, the empirical analysis of the relevant literature let us underline how the cluster research moved over time from clustering-related issues to firm management-related ones.

Other studies have applied these analytical tools to the study of evolution of the cluster concept (Cruz and Teixeira 2010; Lazzeretti et al. 2014; Hervás-Oliver et al. 2015). However, none of them have used keywords as tools to analyze the content of the literature and its evolution over time. This is what we do in this article, combining content analysis with bibliometric and social network analysis. The chapter builds on a previous work developed by the authors (Lazzeretti et al. 2014) and in particular on the original database that was built on that occasion, which included a set of 1586 articles on cluster research, collected by ISI–Thomson Reuters Web of Science database (henceforth, ISI), which have been published from 1989 to 2010 in 250 international scientific journals. From this database, we identified a number of founders of the cluster literature, i.e., articles upon which the cluster literature is based, and disseminators of the cluster concept, i.e., the most cited articles on cluster written in the overall period.

In order to give a comprehensive picture of the evolutionary trajectories of the concept, in this work we complement the existing dataset by adding the forward literature. In particular, by performing a forward citation analysis, we added the articles that cite all the previously identified founders of the cluster literature. The latter analysis is based on 8381 ISI articles, published in 829 journals.

We observe the evolution of the cluster literature alongside two main dimensions: (1) publication outlets and (2) paper keywords. These two are the most used tools to conduct bibliometric analysis. The analysis of paper keywords is performed both through the observation of most used keywords and through the analysis of clusters of keywords that are most frequently found together.

On the one hand, the analysis of publication outlets helps us in defining the general boundaries of the discipline. In this realm, we find out that, although the concept of cluster has fertilized many contributions that were published in the field of economic geography, most of the biggest contributors to the scientific debate on the subject belong to the fields of management and innovation. On the other hand, the analysis of paper keywords gives us a more fresh insight on the specific topic developed by the authors. We divided the forward citations in three periods: the first one corresponds to the 1990s, the second one corresponds to the 2000s, and the third and final one runs from 2010 to 2013. This latter analysis produces a hybrid picture, where new keywords emerge in the second period, which define the new trajectories of the concept. We find that the cluster literature is evolving from economic- and sociological-related issues to management-related topics, where innovation and firm performance are the leading issues.

The chapter develops as follows. Section 2 explains in detail the dataset we have used for our empirical analysis. Section 3 presents the main results of the analysis of publication outlets, while Sect. 4 deals with the analysis of the keywords used by the authors. By using some social network analysis tools, Sect. 5 presents an analysis on the clusters of keywords that are most frequently found together. Section 6 discusses

the main results of our analysis on the evolution of the cluster literature and provides some concluding remarks.

## 2 Data and Methodology

The starting point of our analysis on the evolution of the cluster concept is represented by a previous work, done by the authors, which looked at the roots of the concept and identified a number of founders and disseminators of cluster literature. In order to identify these two different populations of articles, we referred to the ISI database.<sup>1</sup> In particular, after having performed an advanced search on “industrial district\*” or “cluster\*” as topic in ISI (only in some subsets of subject categories and only from 1989 to 2010)<sup>2</sup> and having excluded the intruders (e.g., articles in which the term “cluster” was referred to the cluster analysis technique), we obtained a database that included 1586 journal articles that have been published in 250 international journals. Then, we identified the most cited articles—46 papers that have collected at least 10 citations on average (by year)—which represent the “disseminators” of the cluster concept.

The founders of the cluster concept were identified on the basis of a backward citation analysis performed on the disseminators. The founders include the prominent works of Alfred Marshall (1920) and Michael Porter (1990, 1998) but also those of Giacomo Becattini (1990), Paul Krugman (1991), Allen Scott (1988), and Michael Storper (1997). Through the use of some social network analysis, we identified different scientific communities (ten communities) in which the founders can be grouped. These communities are meaningful groups of references that are connected by the presence of a theme, an author, a concept that is linked to the cluster concept, or—more often—the common membership to the same scientific area.

We have built on this existing database, as well as on our previous analysis, in order to look at the evolution of the cluster literature. Through a forward citation analysis on the founders, we have identified all ISI articles—written from 1985 to 2013—that cite these milestones of the cluster literature. In order to consider only the relevant literature, we have considered only the articles that cite more than one founder. Moreover, in order to maintain the interdisciplinary approach that characterizes this literature, we have included only the articles that cite founders belonging to more than one scientific community.

As a result, we obtained a database including 8381 ISI articles, published in 829 journals. In order to deepen our understanding of the evolution of the concept

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<sup>1</sup>The choice of ISI as the referring database was motivated by its widespread international use for rating the research output of scientists in every discipline. However, in Lazzeretti et al. (2014), we also acknowledge the limitations of such database for research purposes.

<sup>2</sup>As explained in detail in Lazzeretti et al. (2014), we chose to consider both the cluster and the industrial district, because these two concepts are strongly interconnected (see also McEvily and Zaheer 1999; Porter and Ketels 2009).

alongside new trajectories, we have performed a content analysis. In particular, we have collected the keywords used by the different authors to describe their articles (as reported by the ISI database) and we have analyzed their meaning and their evolution over time. The 8381 ISI articles we included in our database use 4820 keywords.

### 3 Analysis of Publication Outlets

In order to identify the main scientific fields in which the cluster literature develops, we observe the scientific journals in which the forward literature was published. The literature develops over a very high number of scientific journals (829 journals) and shows the typical structure of a long-tail distribution, with a small subset of journals that have published a very high number of articles and a very large portion of journals that rarely host articles on the topic (Fig. 1). Indeed, only about 7% of the observed journals publish at least one article per year on average (i.e., at least 29 items in 1985–2013). On the other hand, about 41% of the journals host only one contribution that can be considered related to the cluster literature.

The following Table 1 shows the top journals in which the forward literature has been published. Although some of the most relevant journals in the field of economic geography are in the list (*Regional Studies*, *Journal of Economic Geography*, *Economic Geography*, *European Planning Studies*), the largest part of articles is published in innovation or management journals such as *Research Policy*, *Strategic Management Journal*, or *International Journal of Technology Management*.

In order to analyze the time evolution of the forward literature, the following Table 2 splits the time period observed into two sub-periods (1985–1999 and 2000–2013) and lists the 15 top scientific journals in terms of number of articles published in each of the two periods. The management and innovation literatures dominate the scene in both periods. In particular, the management literature prevails in 1985–1999, while innovation studies become predominant in the second period. In 1985–1999 the list of most relevant outlets also includes economic and sociological journals, which however disappear in the second period.



**Fig. 1** The long-tail distribution of the forward literature. Source: Authors' elaboration

**Table 1** Most relevant scientific journals in the forward literature in terms of number of articles published (percentage on the total number of articles in the forward literature, 1985–2014)

Scientific journal	Pct of articles
<i>Research Policy</i>	373
<i>Regional Studies</i>	347
<i>European Planning Studies</i>	301
<i>Strategic Management Journal</i>	299
<i>Environment and Planning A</i>	188
<i>Organization Science</i>	164
<i>International Journal of Technology Management</i>	148
<i>Technovation</i>	139
<i>Journal of Management Studies</i>	135
<i>Journal of International Business Studies</i>	125
<i>Journal of Economic Geography</i>	114
<i>Academy of Management Review</i>	106
<i>Urban Studies</i>	104
<i>Economic Geography</i>	100

Source: Authors' elaboration

## 4 Content Analysis

In what follows we present the results of the content analysis on articles' keywords. We start our observation from the 1990s, because this is the period in which, after the publication of the famous contribution of Michael Porter (Porter 1990), the cluster concept emerged more clearly on the global scenario. At that time, the debate on the industrial district was already started (cfr. Becattini 1979), but the very end of the 1980s to early 1990s witnessed the first publications on the topic in international journals or volumes edited by international publishers (Brusco 1986; Becattini 1989, 1990; Bellandi 1989).

We divide now the period in three parts: the first one corresponds to the 1990s, the second one corresponds to the 2000s, and the third and final one runs from 2010 to 2013. Our analysis excludes the keywords that are present in all time periods, which evidently are not able to characterize a specific moment in time. Network is one example of such words. This keyword is not included in the list because—not surprisingly—it is one of the catchwords that are present along the whole period under observation. The following Table 3 presents the results of our analysis.

The first period is characterized by a series of keywords that focus on the flexibility issues. The debate on flexible specialization is the result of the reception of the book written by Piore and Sabel (1984), which raised new questions about the development model that, at that time, characterized the capitalist countries. Their contribution on post-Fordist models of production gave a strong impetus to the spread of the concept of industrial district. Following the authors, industrial districts should have been considered a building block for the creation of a sustainable growth path. Such pattern of growth would have been an alternative to mass

**Table 2** Most relevant scientific journals in the forward literature in terms of number of articles published (first 15 journals, percentage on the total number of articles in the forward literature in the two periods 1985–1999 and 2000–2013)

Scientific journal	1985–1999	Scientific journal	2000–2013
<i>Strategic Management Journal</i>	5.4	<i>Research Policy</i>	4.7
<i>Environment and Planning A</i>	5.0	<i>Regional Studies</i>	4.2
<i>Regional Studies</i>	3.9	<i>European Planning Studies</i>	4.1
<i>Academy of Management Review</i>	3.3	<i>Strategic Management Journal</i>	3.3
<i>Research Policy</i>	3.1	<i>International Journal of Technology Management</i>	1.9
<i>Administrative Science Quarterly</i>	2.9	<i>Technovation</i>	1.9
<i>Organization Science</i>	2.9	<i>Environment and Planning A</i>	1.8
<i>Economic Geography</i>	2.5	<i>Organization Science</i>	1.8
<i>Small Business Economics</i>	1.9	<i>Journal of Management Studies</i>	1.6
<i>Organization Studies</i>	1.8	<i>Journal of Economic Geography</i>	1.6
<i>American Journal of Sociology</i>	1.5	<i>Journal of International Business Studies</i>	1.5
<i>Cambridge Journal of Economics</i>	1.5	<i>Entrepreneurship and Regional Development</i>	1.3
<i>Urban Studies</i>	1.5	<i>Industrial and Corporate Change</i>	1.2
<i>Journal of Management Studies</i>	1.4	<i>Urban Studies</i>	1.2
<i>World Development</i>	1.4	<i>Academy of Management Journal</i>	1.2

Source: Authors' elaboration

production, which in the mid-1980s was definitely in crisis. In their famous book, the authors discussed the fact that one of the district strengths was the flexibility of small enterprises located within its boundaries, as well as the flexibility of the district as a whole. It is known that such flexibility comes from the fact that the specialized competencies of the firms operating along the local value chains can be quickly assembled in a variable way in order to manufacture different products. This means that product differentiation and innovation, which were needed to compete after the crisis of the mass production system, were within the reach of the small firms of the industrial districts, more than of large and cumbersome corporations.

Keywords such as flexibility (on top of the list of most popular keywords), flexible accumulation, Fordism, post-Fordism, flexible specialization, and flexible production are related to this debate, which was very lively in these years (see also Storper and Christopherson 1987; Kenney and Florida 1988; Christopherson and Storper 1989; Storper and Harrison 1991; Hirst and Zeitlin 1997; Storper 1995; Sabel 1999).

**Table 3** Keywords characterizing the periods 1990–1999, 2000–2009, 2010–2013

1990–1999		2000–2009		2010–2013	
Keyword	Freq (%)	Keyword	Freq (%)	Keyword	Freq (%)
Flexibility	1.07	Knowledge spillovers	0.77	Knowledge spillovers	1.17
Location	0.90	Patent citations	0.62	Knowledge transfer	0.95
Flexible accumulation	0.70	Proximity	0.62	Patent citations	0.86
Silicon Valley	0.65	Knowledge transfer	0.56	Structural holes	0.62
Growth dynamics	0.62	Tacit knowledge	0.53	Innovation systems	0.48
Embeddedness	0.62	Semiconductor industry	0.50	Weak ties	0.48
Social structure	0.62	Organizational knowledge	0.38	Buzz	0.46
Trust building	0.62	Innovation systems	0.33	Semiconductor industry	0.32
Collaborative behavior	0.59	Intellectual property	0.30	Exploration	0.28
Transaction cost approach	0.51	Heterogeneity	0.27	Organizational knowledge	0.28
Fordism	0.36	Structural holes	0.27	Start-ups	0.28
Post-Fordism	0.36	University-industry	0.27	Exploitation	0.27
Flexible specialization	0.34	Collective learning	0.24	Intellectual property	0.26
Flexible production	0.31	Foreign subsidiary	0.15	Pipelines	0.25
Institutions	0.25	Venture capitalists	0.15	Global production network	0.22

Source: Authors’ elaboration

Another scholarly debate that characterizes the 1990s is about Silicon-like regional economies (or regional networks). The famous book written by AnnaLee Saxenian (1994) brings a growing interest in the origins and dynamics of production networks in Silicon Valley (see also Saxenian 1990, 1991 or the more recent Saxenian and Hsu 2001). Silicon Valley with its booming semiconductor industry becomes an example of how interfirm networks can support the technological dynamism of a region. The book of 1994 opens to the study of regional networks and how these can support the coevolution between firms social structures and local institutions. The keyword “Silicon Valley” is (obviously) directly related to this debate. Keywords such as social structures growth dynamics collaborative behavior embeddedness and institutions are also related to this debate.

The transaction costs approach is often used to explain the particular web of relationships that characterizes these local or regional networks (see Dei Ottati 1994, for the case of the industrial district). Hence, we found this term in the list of keywords that characterize the period. Part of the cluster literature that is published

in these years—typically that in the field of geography—focuses on the topic of localization (location of firms and clusters).

In the decade 2000–2009, literature becomes increasingly focused on innovation. The most relevant keyword that characterizes the period is knowledge spillovers (together with absorptive capacity, which however is not included in Table 3, because it is very much diffused also in the other two periods), which becomes one of the key concepts to understand the atmosphere that characterizes innovation clusters (e.g., Audretsch and Feldman 2004; Bathelt et al. 2004; Dahl and Pedersen 2004; Audretsch and Lehmann 2005; Niosi and Zhegu 2005; Iammarino and McCann 2006). Connected to knowledge spillovers—and, in particular, to the empirical measurement of this concept—we also find the keyword “patent citations” (Jaffe and Trajtenberg 2002; Maurseth and Verspagen 2002; Thompson and Fox-Kean 2005).

Some keywords refer to the key concepts that characterize the studies on innovation in the 2000s. The first concept is the discovery of the role that territorial proximity can play in triggering innovation. Proximity refers to this concept, together with “tacit knowledge” and “collective learning.” The debate on collective learning starts at the end of the previous decade (Capello 1999; Keeble et al. 1999) and continues in the 2000s by putting more emphasis on its consequences for endogenous development (see, for instance, Capello and Faggian 2005).

The second concept is that of innovation system (Carlsson et al. 2002) and particularly that of territorial innovation system (Lundvall et al. 2002; Cooke et al. 2004). Born in the previous decade, the concept of regional innovation system develops along the first half of the 2000s (Kaufmann and Tödtling 2000; Cooke 2001; Cooke et al. 2003; Asheim and Isaksen 2002; Asheim and Coenen 2005; Doloreux and Parto 2005; Belussi et al. 2010). This debate is intertwined in various ways with the one on technology transfer and university-industry relationships, which is the third key concept characterizing the decade (Acs et al. 2002). Keywords such as knowledge transfer, university-industry, intellectual property, and venture capitalists are related to this debate.

In this time period, keywords related to micro-level units of analysis—typically, the individual firm—enter the top list of the most popular keywords. Organizational knowledge is one of such keywords. Although the concept is defined in the previous decade, the related debate continues to develop in this period (Bollinger and Smith 2001; Tsoukas and Vladimirou 2001; Nonaka et al. 2006; Nonaka and Von Krogh 2009). Its presence in the list depends, on the one hand, by the fact that management scholars analyzing the individual organization are increasingly aware of the importance of the external environment to foster firm learning (innovation, development, etc.). On the other hand, scholars analyzing territorial systems (clusters, districts) show a greater sensitivity to the individual system components. Other firm-related keywords refer to the cross-fertilization between the studies on multinational firms and those on clusters. Keywords referred to studies on multinationals are also common in the previous decade, but during the 2000s their number and use increase.

The number of firm-related keywords included in the top list increases in the period 2010–2013. Indeed, keywords such as “organizational knowledge,”



“exploration,” and “exploitation” either enter the top list or confirm their presence (Russo and Vurro 2010; Yang et al. 2010). Even scrolling down the ranking (not displayed here), we find many keywords related to knowledge management and the innovative capacity of the individual firm (e.g., “ambidexterity”). Keywords related to the meso-level studies on innovation and technology transfer (“knowledge spillovers,” “knowledge transfer,” “patent citations,” “structural holes,” “innovation systems,” weak ties,” “buzz,” and “pipelines”) are however on top of the list.

## 5 Social Network Analysis

In order to identify some meaningful core themes that characterize the literature of the last 30 years, we used a mix of instruments coming from the fields of bibliometric analysis and social network analysis.

Using the tools of the social network analysis, we have built a network that ties together each article in our database with its keywords (two-mode network). Then, we have transformed it into a one-mode network made of keywords only. In particular, we have generated three networks related to the time periods considered before (1990–1999; 2000–2009; 2010–2013). After having removed the words “cluster” and “district” (and all their variations) and deleted all words that are used only once and couples of words that are found together only once (i.e., dyads linked by only one relation), we have obtained three networks including, respectively, 361, 835, and 1016 keywords. We then applied a clustering algorithm to identify meaningful combinations of keywords that are most frequently found together. In particular, we have implemented the island routine that is included in the Pajek software (Batagelj and Mrvar 1998; De Nooy et al. 2011), which identifies connected small subnetworks of a larger network with stronger internal cohesion than its neighborhood (namely, islands). Each node of the same island (each keyword, in our case) is linked with some other nodes in the same island through a relationship having a weight at least  $t$ .<sup>3</sup> As a result, we obtained 17 islands in the network 1990–1999, 33 islands in 2000–2009, and 43 islands in 2010–2013. Figures 2, 3 and 4 display only the largest islands we detected in the three networks.

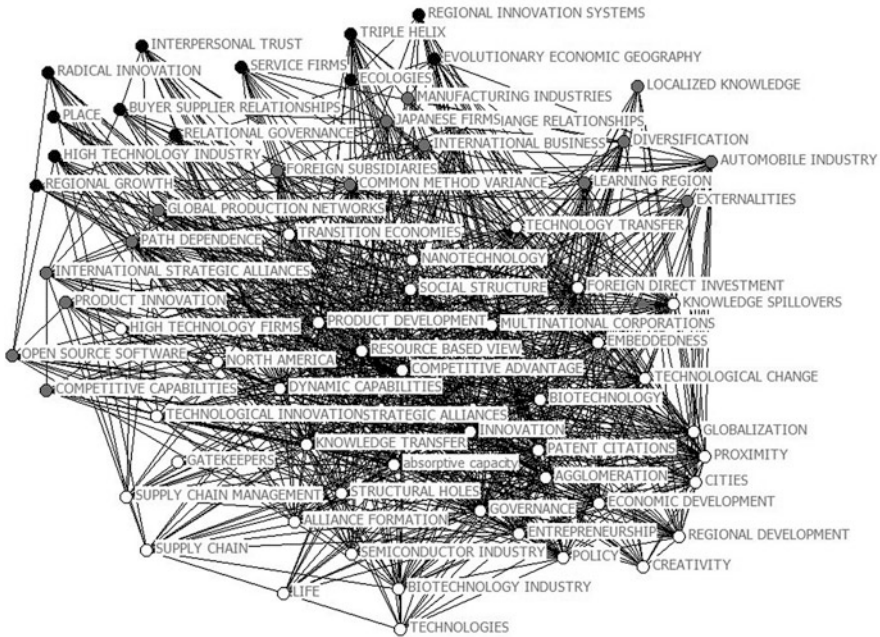
These islands show a different aspect from the most cited keywords that are displayed in Table 2. Looking at the three networks, we can identify some islands of keywords, which do not necessarily include the most common keywords, that are mostly used jointly. Different islands are marked with different colors.

In all networks, islands include keywords that are characteristics of a management approach, together with keywords related to geography, economic geography,

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<sup>3</sup>Note that the nodes that are included in an island can also be connected to other external nodes, which are not part of the same island. After several trials, we choose to identify islands in the range 3–20, which means that the minimum size of the island must be 3 nodes, while the maximum must be 20 nodes (keywords, in our case).





**Fig. 4** Keywords’ islands in the cluster literature in the time period 2010–2013. Note to figure: Only the three largest islands are displayed. Different islands are highlighted in different colors, from black to white. To make the image readable, the thickness of the lines that connect the nodes of the network is not highlighted (i.e., all the lines are set to the same minimum thickness of 1)

in white, refers to the analysis of different patterns of innovation in regions and clusters. Both islands mix keywords that refer to the single firm with others that refer to meso-level units of analysis. The debate on regional growth is at the center of the two remaining islands, with the first island (highlighted in light gray and located in the upper part of the graph) focusing on learning regions and the second (highlighted in dark gray and placed between the just-mentioned island and the one highlighted in black) focusing on flexible specialization.

The four islands that are highlighted in the second graph of Fig. 2 include keywords that refer, again, both to micro- and meso-level units of analysis. For an easy readability of the graph, the frequency with which these keywords are jointly cited is not highlighted in the picture. However, it is easy to note that in this second time period, there is a general increase in connections, which means that many of the keywords displayed in the graph are used jointly. The largest island (highlighted in white) and the island highlighted in black (on top of the graph) refer to innovation and organization studies. These islands mix firm- and cluster-level approaches. The island highlighted in dark gray (left-hand side of the graph) refers to internationalization and multinational companies and mostly adopts a micro-level approach. Finally, the island highlighted in light gray (bottom of the graph) refers to regional development and cities.

The mix between firm-level and cluster-level keywords is even more evident in the islands that are identified in the third part of Fig. 2, which is related to the network from 2010 to 2013. Innovation-related terms are dominant in the three clusters displayed, and organizational approaches, related to knowledge management, are scattered in these islands. The island highlighted in white includes keywords that focus on knowledge absorption from external sources. The island highlighted in gray focuses on international studies and on international strategic alliances in particular. The island highlighted in black is more focused on knowledge management. It includes keywords such as “knowledge-based theory,” “knowledge management,” and “organizational ambidexterity.” However, it also includes meso-level keywords such as “regional growth” that are related to clusters, regions, or cities.

## 6 Conclusion

Based on a previous contribution of the authors, which identifies the founding fathers of the cluster concept, this chapter has discussed the most recent evolution of the cluster literature. In particular, combining content analysis with bibliometric and social network analysis, the paper analyzes the evolution, since the 1990s, of the cluster literature by focusing on the keywords used by the authors to describe their work. The use of this mix of tools adds some novelty to previous analyses on the evolution of the cluster literature. In particular, the analysis of keywords is particularly appropriate for the exploration of the content of the literature, which changes over time.

To perform our analysis, we have built an original database that includes the literature that cites the founding fathers of the cluster concept, and we have collected information in particular about the journals on which this forward literature is published and the keywords used in the various citing articles.

Our main findings can be summarized as follows. The previous work by Lazzaretto et al. (2014) shows that interdisciplinarity is a fundamental character of the cluster literature. The analysis of keywords developed in this chapter confirms this aspect. In fact, throughout the period observed, from the beginning of the 1990s to 2013, keywords that are related to meso-level analysis (cluster and district in the first place, but also city, region, or network) combine with keywords related to micro-level analysis (the single firm or some aggregation of firms). However, the analysis of the most cited keywords, which we carried out by considering the three periods 1990–1999, 2000–2009, and 2010–2013, shows that the most recent period has witnessed the diffusion of keywords that refer to the individual firm and particularly to the mechanisms that allow it to learn, innovate, and create value.

The second part of the analysis is related to the network we constructed starting from the information related to the connection between each article in our database and the keywords it identifies. After having applied some simple social network analysis tools, we identified some islands of keywords that are most frequently found

together. This analysis confirms the trend described above. In fact, in all time networks (1990–1999, 2000–2009, and 2010–2013), clusters include keywords that are typical of a management approach, together with keywords related to geography, economic geography, economics, or sociology approaches. However, the mix between firm-level and cluster-level keywords is more evident in the clusters that are identified in the final time window (2010–2013), and it is testimony to the growing importance of firm-level analysis.

This trend can be explained by the presence of two main forces. On the one hand, management scholars analyzing the individual organization are increasingly aware of the importance of the external environment to foster learning (innovation, development, etc.) in firms. Therefore, over time, such scholars have become sensitive to the analysis of firms into contexts, and in particular in various types of meso-level contexts, such as the cluster (but also the city, the region, the network, etc.). On the other hand, scholars analyzing territorial systems (clusters, districts) progressively show a greater sensitivity to the individual system components. Indeed, the most recent literature on clusters recognizes that the full understanding of meso-level systems requires the understanding of the behavior of firms that populate, originate, and modify them with their strategic choices.

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