

Clusters Models, Factors and Characteristics

by

Catalin Boja

Economic Informatics and Cybernetics Department

The Bucharest Academy of Economic Studies

catalin.boja@ie.ase.ro

Abstract. The industrial cluster concept has become a subject of intense research studies and economic analysis starting with the study conducted by Michael E. Porter regarding the competitive advantage of nations. This concept is an economic phenomenon that is placed in a competitive context in which many businesses simultaneously compete and collaborate to gain different economic advantages. The economic advantages of successful real economic clusters has proves an important reason for the increased attention that this economic model has received from the scientific community and the governmental structures. Despite the advances in cluster research, its model remains a complex one and something that it's hard to reproduce in a real economic environment. The paper highlights typologies of clusters, models of determinant factors and its characteristics by doing a survey of the cluster literature. The research is conducted starting with the analysis of the cluster concept, based on different accepted descriptions. From this point there are summarized the main characteristics and are described models of cluster determinants. The objective of the paper is to highlight the importance and advantages of clusters but also the complexity of the cluster model mainly because of its complex determinant factors.

Key words: Cluster; Characteristic; Model; Regional Development.

JEL classification: R11

1 Clusters

The cluster concept has become a subject of intense research studies and economic analysis starting with the study conducted by Michael E. Porter (Porter, 1990) regarding the competitive advantage of nations. The cluster is an economic phenomenon that is placed in a competitive context in which many businesses simultaneously compete and collaborate to gain different economic advantages. Although there are globally recognized clusters examples such as Hollywood or Bollywood in film industry, wine industry in California, information technology in Silicon Valley and Boston, economic research must provide models that can be applied to a lower regional level so that economy policy makers can identify or help start clusters initiatives.

Actual state of research regarding the cluster concept has evolved based on studies that were conducted on firms agglomerations. The study has started with four empirical observations (Marshall, 1890), (Krugman, 1991), (Malmberg, Solvell and Zander, 1996):

- most of the world or national economic or industrial areas are concentrated in very few regions;
- organizations operating in certain domains tend to locate in common areas;
- over time, the firms place in economic agglomeration persist and have a longer life than other isolated companies;
- in cluster the innovation process is more accentuated.

Specific positive effects and results that support this behaviour and have been observed in the analysis (Marshall, 1890) (Krugman, 1991):

- reduced financial, time and transport costs;
- a larger labour pool of specialized workforce;
- easier transfer of information.

Marshall (Marshall, 1890) uses the term "*industrial districts*" to describe the advantages generated by locating businesses in the same geographical areas. This form of cluster is different from the concept of *urban agglomerations*, which includes companies from various fields located in the same urban area, because companies are performing similar

or interconnected activities (Malmberg, Solvell, Zander, 1996).

Marshall has defined a model that does not take into account the social relations between cluster members. This was observed by economists as Sforzi (Sforzi, 2002) and Becattini (Becattini, 2001) analyzing a number of clusters formed in the rural areas of Italy, the Emilia-Romagna region, around small workshops. The clusters success in this Italian region is explained by the social relations among community members. The region has not benefited from direct governmental support and also had minimal influence from Porter's diamond (Porter, 1990) factors. Workshop staffs shared the same culture, speak the same language in technical terms and had developed trust relations between them. The social capital of the cluster had a major impact in the development of the clusters. Also, this type of capital is difficult to build using artificial techniques as in the case of the technological capital that can be acquired and is an important advantage in facilitating the communication and the collaboration specific to cluster models.

The latter studies conducted by Porter (Porter, 1990) and Krugman (Krugman, 1991) highlighted and added new dimensions to Marshall's observations. Despite criticisms regarding the generality of the approach, the widely accepted descriptions regarding clusters are:

"Geographic concentrations of interconnected companies and Institutions in the particular field" (Porter, 1998)

"Clusters are not seen as fixed flows of goods and services, but rather as dynamic arrangements based on knowledge creation, increasing returns and innovation in a broad sense", (Krugman, 1991)

Porter redefine the cluster concept in a new analysis, concentrating on the type of relations that exists between cluster members *"a geographically proximate group of inter-*

connected companies and associated institutions in a particular field, linked by commonalities and complementarities" (Porter, 2000), and defining its boundaries that can *"range from a single city or state to a country or even a group of neighbouring countries"* (Porter, 2000). The latter description extends the concept outside a limited region and takes into account the effect of global markets.

Krugman's and Porter's analyses add to the economic relations and flows of goods the process of innovation that takes place inside the cluster through the transfer of information, know-how and experience.

Morosini gives another definition by describing the cluster as *"socioeconomic entity characterized by a social community of people and a population of economic agents localized in close proximity in a specific geographic region"*, (Morosini, 2004).

Based on these descriptions, the concept of cluster can be characterized by:

- regional economic activity located at all levels: community, geographic area, global;
- it is limited to a specific industry;
- includes both vertical links as supplier-manufacture-dealer-customer chain or horizontal production links as in sectors of the same industry;
- companies have identical or interrelated business areas;
- firms are in competition but through specialization contribute to the cluster development;
- firms proximity generates social and trust relations;
- a common infrastructure used in innovation by rapid transfer of knowledge and because of the support offered by universities and research centres.

Despite theoretical or practical analysis of clusters has not yet defined a generic model that can explain the success and decline of some clusters, the advantages of this phenomenon is recognized and is one of the main reasons for the current focus on clusters (Porter, 1990), (Porter, 1998), (Etzkowitz, 2002), (Morosini,

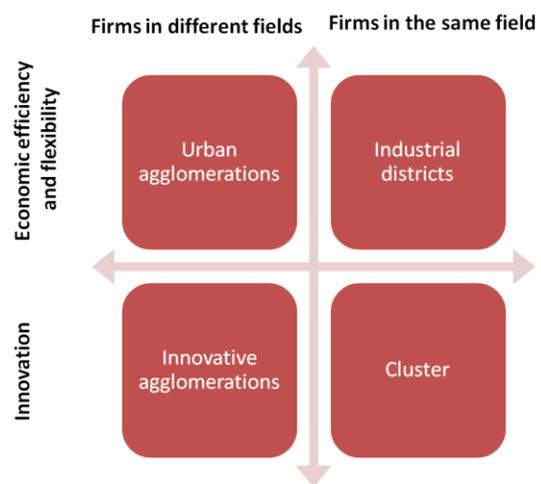
2004), (Carlino, 2001), (Baptista and Swann, 1998), (Sölvell et al, 2003), (Krugman, 1991), (Malmberg and Maskell, 2001):

- a significant local market for products and services; a high concentration of firms generate an increased market and hence more opportunities for reaching to more customers;
- decreased transport costs and supply chains;
- more facile access to resources;
- opportunities for new companies that see new scenarios to extend in this environment;
- offers a higher degree of specialization in products and services;
- more competitive environment that provides better motivation;
- greater cooperation between cluster members; the proximity increases confidence between firms and facilitates communication;
- a concentration of companies with activities in the same area will create a workforce pool that has experience and it is specialized in their field;
- better access to skilled employees;
- the proximity of firms in the same industry allows an exchange of knowledge and ideas through direct contact and free movement of labour, Marshall-Arrow-Romer (MAR) spillove; also, impose on firms a high pace of innovation and higher productivity (Baptista and Swann, 1998); this advantage is determined by the existence of a homogeneous environment in terms of knowledge; the proximity to other companies and direct contact with people in the same field reduce risks and durations of the innovation process because of direct or informal information transfer between partners, companies and their clients or between firms and research institutions (Malmberg, Solvell, Zander, 1996).

2 Cluster models

In order to understand the cluster model from the viewpoint of relations between firms, researchers have been defined different models that take into account supplier chains relations, direct

Based on specific characteristics of urban areas and clusters it is defined a typology (Malmberg, Solvell, Zander, 1996) that describes four different agglomerations, in figure 1, which highlights the conceptual differences between the clusters and the other three models.

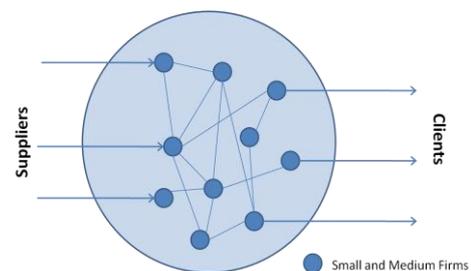


Source: (Malmberg, Solvell, Zander, 1996)

Figure 1. Types of economic agglomerations

Being a type of economic agglomeration, clusters are formed by firms that conduct activities in the same field and in which innovation is an important force that fuels the competition and the firms development, (Porter, 1998), (Krugman, 1991).

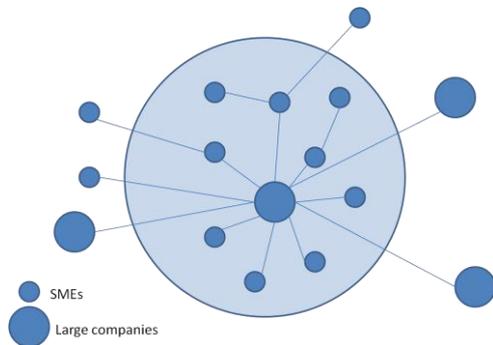
Based on the role of different cluster members and the interaction between them, Markusen (Markusen, 1996), has defined four models of clusters.



Source: (Markusen, 1996)

Figure 2. Marshallian cluster model

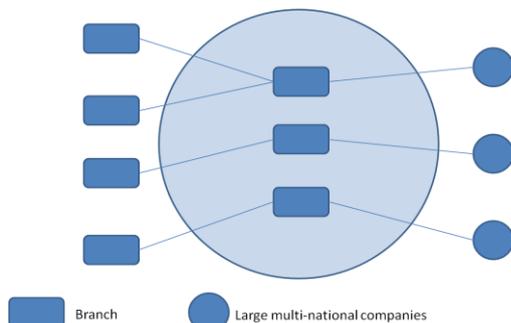
Markusen compare its models of modern clusters with the Marshall one, figure 2, in which the cluster is rather homogenous, comprising small firms that collaborate with each other, are in direct competition or in a supplier-producer relation. In this model, none of the firms has the size and the force to control directly the cluster and only the common market and the cluster dynamic define its shape and development.



Source: (Markusen, 1996)

Figure 3. Hub-and-Spoke cluster model

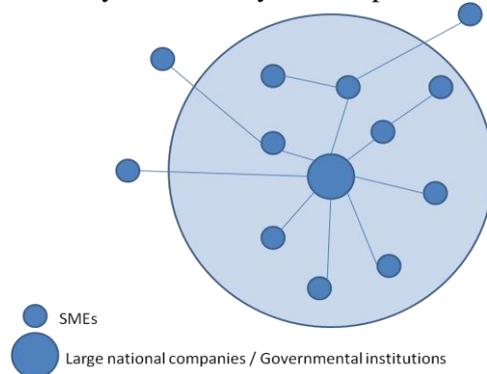
In a hub-and-spoke cluster, figure 2, there are few dominant firms that represent the core of the cluster and are surrounded by numerous small firms that are linked directly to them. The most part of the cluster firms represent suppliers of raw materials, of externalized services or are specialized in a particular phase of the hub production process. The small firms trade directly with the large ones and depend on their client strategy. The hub firms define the relation inside the cluster and its dynamics. Clear examples of hub-and-spoke clusters are found in automotive industry, like Detroit Auto cluster that is concentrated around the “Big Three” auto manufacturers.



Source: (Markusen, 1996)

Figure 4. Satellite Platform cluster model

In a satellite platform cluster, figure 4, a group of branch facilities of externally based multi-plant firms, (Markusen, 1996) are located in a particular geographic region in order to benefit from governmental facilities or low costs with supplies and workforce. A particular characteristic of the satellite platform is that there are no relations between satellite firms and they are entirely controlled by the remotely located parent firm.



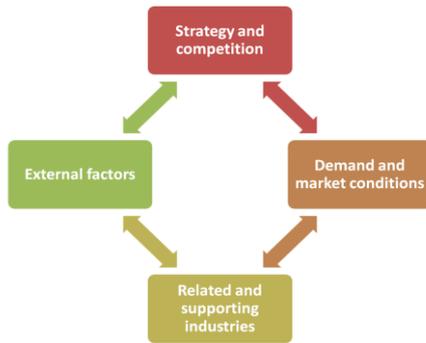
Source: (Markusen, 1996), (He and Fallah, 2011)

Figure 5. State Anchored / State centered cluster model

The last category, the state centered (He and Fallah, 2011) or state anchored cluster, (Markusen, 1996) is defined around a public, governmental or non-profit organization that dominates the region and the economic relation between cluster members. This entity, which in many US scenarios is a large military base, is surrounded by numerous small firms that benefit from public-private contracts. The state centered type can be compared to a hub-and-spoke cluster in which there is one dominant key player that is not controlled by the private sector.

3 Models of clusters determinants

The Competitive Advantage of Nations (Porter, 1990) research describes the successful model of technology clusters like Silicon Valley which is based on several factors not present in the classical theory of economic development which is based on availability and abundance of production factors.



Source: (Porter, 1990)

Figure 6. Porter's Diamond

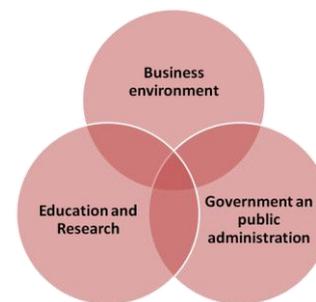
These factors form a model, Porter's diamond, described in figure 6. This model is characterized by interdependence relations between all factors and in the Porter's vision is the engine that drives the cluster at microeconomic level:

- the initial resources of the area and the existing economic environment; initial resources are not always material but rather a series of conditions which facilitate starting a new business; also the economic environment is described by the number of firms operating in a field, the ability to launch a new business and the entrepreneurial culture of the area;
- companies strategies and the competitive environment influence their evolution as they are required to provide specialized services and products, increased quality and collaboration to meet higher requirements; companies are forced to face an environment of increasingly competition and the efficient solution is to evolve, to innovate and provide varied products and services;
- market conditions represents the demand for offered products and services; in Porter's diamond the factors are influencing the cluster evolution but they are also interconnected, influencing each other; without a need or a client, there won't be an entrepreneurial initiative to see an opportunity in the region resources; in the end the initial market will increase due to the cluster competitive environment;

- related and supporting industries describe the factors that allow cluster firms to evolve and maintain their competitive advantages; in terms of innovation, important factors are university and research centres that may provide new technology needed in production processes.

Another important factor for cluster development is the innovation and the continuous exchange of information by:

- direct transfers based on technology cooperation or acquisitions;
- indirect transfers through workforce migration or by analysis and observation of the competition;
- indirect transfers through spin-off by supporting new businesses based on ideas and technologies resulted from research.



Source: (Etzkowitz, 2002)

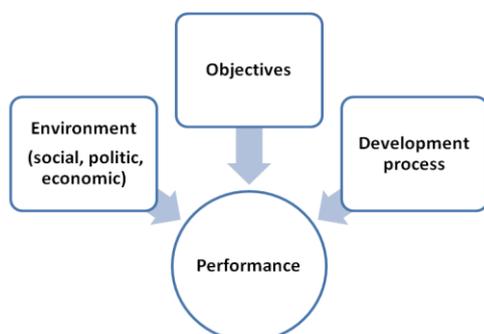
Figure 7. The Triple-Helix Model

In the Triple Helix model (Etzkowitz, 2002), figure 7, the capitalization and transfer of knowledge is defined by the relationships between three important factors for a cluster development: education, government and business. Among these components there is a relationship of academic-industry-government type (Etzkowitz, 2002) in which each component is independent of the other but overlap in terms of innovation and knowledge transfer. Also, each component has an equal role and takes over the leading role as an innovation generator. This model differs from models in which each factor is independent of the other three without a clear relationship between them or from models in which education and research is part of a larger public system run by the state.

The Triple-Helix model is based on close cooperation between the three factors:

- universities and research centres are involved in projects, financed by the private sector, to deliver technology, knowledge and to innovate; new business can be created using spin-off technology and financial support from private companies;
- business environment involves higher education in research projects and supports private entrepreneurship;
- government financed research; in the United States military research facilitates generates economic clusters through outsourcing different services to private companies; regional development initiatives and projects which support the development of technological parks can represent the starting point for future agglomerations that can lead to a cluster.

The Cluster Initiative Performance Model (CIPM) (Sölvell et al, 2003), described in figure 8, is used to describe in detail influencing factors for the development of cluster initiatives that support clusters or can lead to the development of a new one. Although cluster initiative represent projects that support companies from the cluster (Sölvell et al, 2003) and implicitly to the cluster are therefore considered important in this analysis. In this model there are four factors which have a dependency or cause-effect relationship. Factors affecting performance or success of the cluster initiative are:



Source: (Sölvell et al, 2003)

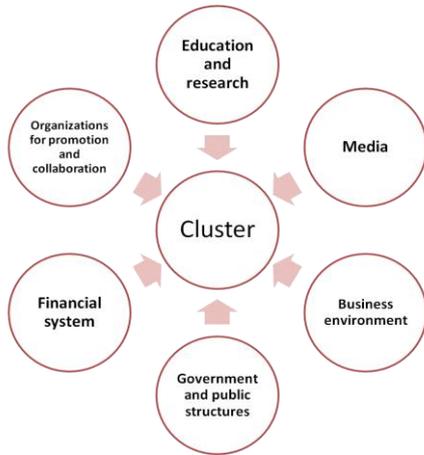
Figure 8. The Cluster Initiative Performance Model (CIPM)

- social, political and economic environment; because clusters are recognized as national or regional development tools, many initiatives are launched by governmental projects financed from public funds or public-private partnerships; also the social, cultural and economic conditions describing region should allow the launch of such initiatives;
- initiative objectives can be placed into six general categories (Sölvell et al, 2003): research and development of research networks, private lobby and communication with the political sector, commercial cooperation, development of educational infrastructure, innovation and development of new technologies, development and extension of an existing cluster.
- the development process describes stages in the cluster initiative life cycle: initiation and planning, managing and funding the initiative, management of cluster members and policies to attract firms, the creation of an administrative unit to promote the initiative, the consolidation of internal resources and processes that will enable the initiative to further develop in an independent way.

Based on the CIPM initiative model, the cluster initiative performance is evaluated on:

- the number and complexity of links between industry and research;
- the increase level of competitiveness on a international scale;
- degree of innovation achieved through development of new technologies;
- development of the cluster by attracting new businesses, by increasing production and its market;
- degree of achieving objectives.

Another model defined by Sölvell (Sölvell, 2008), (Sölvell et al, 2003), figure 9, is built around the actors which decisions and actions can influence the cluster development:



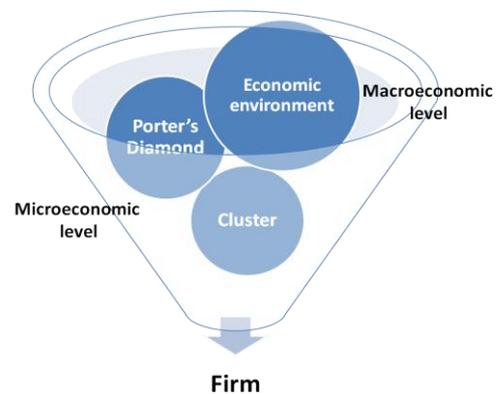
Source: (Sölvell, 2008)

Figure 9. Cluster factors model

- the government by its central and local structures may launch regional development projects, can provide financial incentives to attract new investors or can define structures or agencies to manage cluster initiatives or regional development;
- the financial system represented by banks, investment companies or other financial networks provide the necessary support for entrepreneurial initiatives which generate new businesses or expand existing ones; comparing two of the most successful technology clusters, Silicon Valley and Boston Route 128, Saxenian (Saxenian, 1996) highlighted the difference in banks and venture capital investors attitude to support the development of the Californian cluster and the East one; the West coast open attitude, motivated by the entrepreneurial culture of the region, supported the dynamic development of the cluster which has exceeded the performance of the Boston counterpart;
- the education and research system consisting in university centres and research institutes, generates or supports the innovation process by providing a pool of qualified and specialized workforce; also the technology or knowledge transfer represents an important factor for the cluster development; in the success story of Silicon Valley cluster, a catalyst for innovation and research in information technology was

represented by Stanford University through Stanford Research Institute and the Stanford Industrial Park (Sölvell, 2008);

- small and medium enterprises (SMEs), public or private companies and multinational corporations represent the core of the cluster; the evolution of these elements and relationships that form between them shape the cluster development model; regardless of the size, complexity and specialization of production processes, the complexity and size of the cluster is given by the number of firms that form it;
- organizations for promotion and collaboration are represented by non-governmental organizations (NGOs), chambers of commerce, associations and government agencies that have objectives regarding launching cluster initiatives intended to support and promote the development of an existing cluster;
- media channels promote cluster initiatives or create a brand that represents the cluster; Silicon Valley brand is one such example, and its success has generated a symbol around there were launched other clusters: Fiber Optic Valley in Sweden, Motorsport Valley in England, Flanders Multimedia Valley in Belgium, Materials Valley in Germany's Rhine-Main region (Sölvell et al, 2003).



Source: (Sölvell, 2008)

Figure 10. Funnel model of cluster determinants

The cluster is an economic phenomenon that is affected at all economic levels, (Sölvell, 2008), figure 10:

- locally by regional and microeconomic development policies; factors defined by Portes Diamond are present mainly at microeconomic level
- macroeconomic by the global and country economic environment;
- at firm level by the economic relations inside the cluster.

4 Clusters lifecycle

Each cluster is unique regarding its social and cultural environment, companies' activity field, objectives and factors (Sölvell et al, 2003):

- *"Clusters develop over time; they are not a phenomenon that just appears or disappears overnight"* (Ketels, 2003) and clusters do not magically appear in random areas or in regions that theoretically provide the best conditions; clusters are initiated in regions where there have been previous, where a number of companies grouped and have developed economic links for collaboration or competition; also the cluster initiative belongs to a market player, a *"clusterpreneur"* (Sölvell et al, 2003) which has a major influence on it, can support the initiative and can attract other members; in over 60 % of cases (Sölvell et al, 2003) the *clusterpreneur* is the Government that by observing the natural clustering behaviour of existing businesses may initiate autonomous or public-private projects as technology parks; in other cases, private initiatives are started by multinational companies that see expansion opportunities in the region (Leleur, 2009);
- most successful clusters are in technical fields: information technology, medical services, biopharmaceuticals, communications and construction of cars;
- clusters are paced in regions with strong research centres that generate skilled labour pools or support the innovation process; geographic areas with world recognized

universities, public research laboratories are important baseline factors that can support a cluster initiative (Saxenian, 1996) (Leleur, 2009);

- the social and political stability of the region affects companies trust in the public administration, long-term objectives and guarantee an economic environment to justify the investment;
- government policies regarding the development of geographic or economic areas influence the cluster creation and development by attracting foreign investors, providing the infrastructure and taking measures in other areas such as education; in studies made by The Cluster Observatory project (Sölvell et al, 2003) on a significant number of clusters, the government's financial contribution has been seen in over 54% of projects, and another 25% clusters are funded equally by public and private; according to (Sölvell et al, 2003) there are three major sets of policies managed by the government administration, that can influence cluster initiatives: regional or SME policies, policies to attract investments and policies on research and innovation.

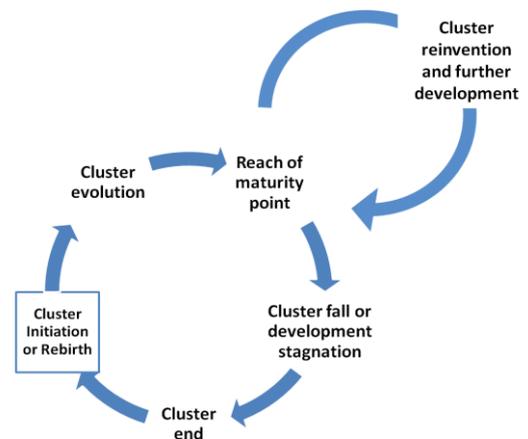


Figure 11. Cluster lifecycle

Life cycle that includes moments like birth, growth, decline and disappearance, which is representative for most business processes is also available for cluster models, figure 11:

- the start or initiation of the cluster is generated by achieving a minimum

threshold of firms operating in a region in the same field or related fields; this agglomeration may take place due to social or economic conditions that foster business development in that area or due to the presence of a catalyst which has seen or generated an opportunity for development; this moment zero is associated with an event, such as the discovery of gold or oil in California or is associated with the vision of an entrepreneur who had a business idea and in time it has created a local market that has evolved into a cluster; such examples include the creation of the textile cluster in Dalton, Georgia (Krugman, 1991) or the automotive winter testing industry in Arjeplog, Sweden;

- the cluster grow attracting or generating new business or building relationships between existing ones; influence factors models affects cluster lifecycle and describe distinct patterns of evolution that cannot be applied generically to any type of cluster; lifecycles can be so specific that same type clusters which benefited from the same original conditions, like Silicon Valley and Boston Route 128, have completely different development paths, mostly because their factors influence (Saxenian, 1996).
- the point of maturity or stability is reached when there are reached the upper limits of development given by a stabilized demand, by exceeding the maximum availability point for a resource or by delaying the emergence of new technologies;
- cluster renaissance describes a time when the cluster resumes development or returns to previous size; the trigger may be given by the introduction of technological innovation, rethinking strategies for identification and entry into new markets or by attracting new companies to support this new development;
- decline and possible dissolution of clusters is generated by relocating to better cost-effective regions of large companies representing the cluster core, by technology changes or by economic events that have major effects such wars or crises.

5 Conclusions

Recognizing the benefits of clusters as a form of economic organization has influenced governments to implement policies (Sölvell et al, 2003), intended to launch initiatives to support existing clusters or to form new ones in regard with:

- Small and Medium Enterprises (SMEs)
- regional industrial development;
- attracting external funds and foreign investors;
- research and innovation at national or local level.

Economic development based on cluster models represent a policy adopted by many economies that can, theoretically, bring multiple benefits in terms of regional development, competitiveness in an industry. Also it can generate an economic environment that will adapt more easily to events such as economic crises or other economic and social transformation. Although existing cluster analysis highlighted their advantages, the interconnection of factors and their effect on the cluster, the economic theory has not yet provided a model that allows both the analysis and the definition of a process for implementing a successful cluster. Due to the complexity of the economic relations and environment that define a cluster, it is necessary to continue research from both theoretical and practical perspectives, so that the theoretical model is validated in practice by overlapping it with any existing cluster case.

Acknowledgment

This work was supported from the European Social Fund through Sectoral Operational Programmer Human Resources Development 2007-2013, project number POSDRU/89/1.5/S/59184, "Performance and excellence in postdoctoral research in Romanian economics science domain".

A preliminary draft was presented as a working paper at the First Scientific Session, 1-2 July, Bucharest POSDRU/89/1.5/S/59184.

References

- Baptista, R. and Swann, P. (1998), Do firms in clusters innovate more?, *Research Policy* 27 (5), 525–540.
- Becattini, G. (2001), *From Marshall's to the 'Italian industrial districts': A brief critical reconstruction*, http://www.tci-network.org/media/asset_publics/resources/000/000/685/original/becattini_marshall.pdf, Accessed 05/ 2011
- Bekele, G W and Jackson, R. W. 2006, Theoretical Perspectives on Industry Clusters, *Research Paper 2006-05*, Regional Research Institute, West Virginia University, USA
- Bergman, E.M. (2008), Cluster life-cycles: an emerging synthesis, in: Karlsson, C. (Ed.), *Handbook of Research on Cluster Theory, Handbooks of research on clusters series*. Edward Elgar, Northampton, MA, pp. 114–132.
- Carlino, G. A. (2001), Knowledge Spillovers: Cities' Role in the New Economy, *Business Review*, Q4 2001.
- Etzkowitz, H. (2002), The Triple Helix of University-Industry-Government: Implications for Policy and Evaluation, *Working Paper 2002: 11*, Science Policy Institute
- European Cluster Observatory (2006), www.clusterobservatory.eu, Accessed 17/01/11
- Harvard Business School - Institute for Strategy and Competitiveness (2011), *The International Cluster Competitiveness Project*, <http://www.isc.hbs.edu/econ-clusters.htm>, Accessed 23/01/11
- He, J., Fallah, M.H. (2011), The typology of technology clusters and its evolution — Evidence from the hi-tech industries, *Technol. Forecast. Soc. Change*, 2011
- INNOVA Project, (2008), *European Cluster Organisation Directory*, www.europe-innova.eu, Accessed 23/01/11
- Krugman, P. (1991), *Geography and trade*, London: MIT Press/Leuven UP, p.142.
- Leleur, R. (2009), *Cluster diversification - A study of innovation processes in the Bangalore IT cluster*, A master thesis submitted August 2009, Copenhagen Business School, <http://studenttheses.cbs.dk>
- Malmberg, A. and Maskell, P. (2001), The elusive concept of localization economies – Towards a Knowledge-based Theory of Spatial Clustering, *AAG Annual Conference*, New York, 27 february – 3 March
- Markusen, A. (1996), Sticky places in slippery space: a typology of industrial districts, *Economic Geography* 72, 293–313.
- Marshall, A. (1920) *Principles of Economics*, 8th edition, London: Macmillan
- Porter, M. E. (1990), *The Competitive Advantage of Nations*, Macmillan, London.
- Porter, M. E. (1998), Clusters and the new economics of competition, *Harvard Business Review*, 76(6), pp. 77–90.
- Porter, M. E. (2000), Location, competition, and economic development: Local clusters in a global economy, *Economic Development Quarterly* 14 (1): 15-34.
- Morosini, P. (2004), Industrial Clusters, Knowledge Integration and Performance, *World Development*, Vol. 32 No. 2 pp. 305-326
- Saxenian, A. (1996), *Regional Advantage: Culture and Competition in Silicon Valley and Route 128*, Harvard University Press, <http://www.google.com/books>
- Sforzi, F. (2002), The industrial district and the 'new' Italian economic geography, *European Planning Studies*, vol. 10, no. 4, 2002.
- Sölvell, Ö., Lindqvist, G. and Ketels, C. (2003), *The Cluster Initiative Greenbook*, Stockholm;
- Sölvell, Ö. (2008), *Clusters, Balancing Evolutionary and Constructive Forces*, Ivory Tower Publishers, Stockholm, ISBN 978-91-974783-3-5.

Author description

Catalin BOJA is Lecturer at the Economic Informatics Department at the Academy of Economic Studies in Bucharest, Romania. In June 2004 he has graduated the Faculty of Cybernetics, Statistics and Economic Informatics at the Academy of Economic Studies in Bucharest. He is a team member in various undergoing university research projects where he applied most of his project management knowledge. Also he has received a type D IPMA certification in project management from Romanian Project Management Association which is partner of the IPMA organization. He is the author of more than 40 journal articles and scientific presentations at conferences.