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# THE ROLE AND PLACE OF THE CLUSTER APPROACH IN THE CURRENT NIS STUDIES

Innovation through creation, diffusion and use of knowledge has become a key driver of economic growth and provides part of the response to many new societal challenges. However, the determinants of innovation performance have changed in a globalising knowledge-based economy, partly as a result of recent developments in information and communication technologies. Innovation results from increasingly complex interactions at the local, national and world levels among individuals, firms and other knowledge institutions. Governments exert a strong influence on the innovation process through the financing and steering of public organisations that are directly involved in knowledge generation and diffusion (universities, public labs), and through the provision of financial and regulatory incentives to all actors of the innovation system. They need a sound conceptual framework and an empirical basis to assess how the contribution of public policy to national innovation performance could be improved. Through a decade of academic research and policy analysis, the National Innovation Systems (NIS) approach has been developed to provide such framework and quantitative information.

Obviously, the organization of innovation within an economy plays an important role in market-based economies and in their institutional set-ups, which is due to the meanwhile uncontested growth-spurring impact of innovation. The results from this study may be relevant to the design and the efficiency of political measures directed towards innovative action on the country level. The reason for this is that the identified different clusters of national systems of innovation show the degree and the areas of structural similarities across the analyzed systems. In this way, the country clusters that are detected may affect the efficiency of mutual learning processes when it comes to the planning, the conduct and the targeted international coordination of technology policy action.

**Key words:** national system of innovation, innovation, technology, cluster approach, Star–model.

**Formulation of the problem.** Features of the present stage of economic development, accelerating the pace of globalization cause high importance of science and technology for economic and social well-being of society. The main economic achievements of foreign countries, in most cases related to the prioritization of science and technology, as well as the state scientific and technical policy. On the other hand, it is those countries which at a certain stage of their development have focused on the quality of life and the main purpose of development identified improving the level and quality of life of its citizens, could through activation of the scientific potential and strengthening the innovation component of the economy to achieve high rates of economic growth and making a serious step towards the creation of a socially oriented economy. Currently, scientists and economists around the world are exploring measurement issues and quantification of various parameters of quality of life, trying to find its objective characteristics. However, comprehensive studies of the relationship between the development of the national innovation system, an innovative component of the economy and changing the quality of life at the moment, are not represented. Despite numerous studies, there are a lot of controversial issues related to the creation of an innovative economy, the emergence of the national innovation system, the commercialization of science, and most importantly - research methods of effective functioning national innovation system.

**Analysis of recent research and publications.** The founders of the modern approach to understanding the problems of formation and functioning of the national innovation system were the following scientists: J.Schumpeter, G.Mensch, R.Solow, E.Toffler, D.Galbraith, F.Mashlup, T.Styoart, D.Tapscott, F.Webster, P.Drucker, J.Masuda, M.Porat, A.Pikkaluga, L.Ferruchchi,

D.Porkeddu, M.Latstseroni, A.Gambardella.

Questions of creation and functioning of innovative clusters contained in the writings of L.Ablasa, M.Bell, E.Dahm, A.Marshall, M.Porter, S.Rosenfeld, E.Hill, M.Enright.

**Setting the objective**. The aim of the article is the theoretical rationale for the study of the national innovation system, and the relevance of the use of the cluster approach in the process. Conceptual genesis of the phenomenon of the national innovation system in this context of globalization

**The basic material of research.** The term national system of innovation has been around for more than 20 years and today it has become widely spread among policy makers as well as scholars all over the world. In this lecture I will take stock and look ahead from a personal point of view. I will give some insight in why and how the concept came about and give some space to criticism and self-criticism. I will mention but certainly not give justice to alternative conceptualizations of innovation system.

As gives OECD, National Innovation System means a core concept for analyzing an economy's capacity to produce, commercialize, import, and utilize knowledge and technology. Innovation, learning and technological development, indispensable for long-term economic development of a nation, are now seen as systemic activities involving many and diverse economic actors. Therefore the NIS concept rests on the premise that enhancing linkages among various actors, especially with respect to knowledge creation, diffusion and use, is a crucial for improving a country's innovative performance.

The innovation system concept was developed in parallel at different places in Europe and in the US in the eighties. There is no doubt that the collaboration between Christopher Freeman and the IKE-group in Aalborg in the beginning of the eighties was important in coining and shaping the earliest versions of the concept[1] (Freeman 1982 and Lundvall 1985) but the basic ingredients and the inspiration may be found in the work of many other innovation scholars before that. Freeman brought deep understanding of innovation processes, historical insight and wisdom to the collaboration. His reference to Friedrich List was crucial since it linked the concept to the role of the state in catching-up processes[2]. The IKE-group, inspired by French structuralist Marxists and development economists, contributed with ideas about 'national production systems' and industrial complexes' where vertical interaction was crucial for performance and outcome and linked this to the analysis of international specialisation and international competitiveness. Within the IKE-group Esben Sloth Andersen and Gert Willumsen played key roles in respectively developing the systemic aspects and the idea of interactive learning between users and producers as the micro-foundation of the concept. Bent Dalum and Jan Fagerberg made important contributions to respectively technology and trade while Björn Johnson brought in perspectives from institutional economics and applied them on innovation. My own starting point was actually the analysis of slack and diversity at the level the firm. The NSI-concept became more widely diffused through Christopher Freeman's book on Japan (Freeman 1987) through a publication edited by Freeman and myself on small countries (Freeman and Lundvall 1988) and not least through the publication of the Dosi et al book on technical change and economic theory with contributions by Freeman, Nelson, Lundvall and Pelikan (Dosi et al 1988). More recent standard references on national systems of innovations are three books edited by Lundvall (1992), Nelson (1993) and Edquist (1996). Other contributions referring to systems and operating at the national level refer to 'social systems of innovation' (Amable et al 1997) and to 'national business systems' (Whitley 1994 and 1996). Over the last decade there have been several new concepts emphasizing the systemic

1 Freeman, C. (1995). The national system of innovation in historical perspective. *Cambridge Journal of Economics, 19 (1),* 5-24.

2 Lundvall, B-Å. (2007). National Innovation Systems: analytical concept and development tool. *Industry & Innovation, 14(1),* 95-119.

characteristics of innovation but with focus at other levels of the economy than the nation state[1]. Bo Carlsson with colleagues from Sweden developed the concept 'technological systems' in the beginning of the nineties (Carlsson and Stankiewitz, 1993). The literature on 'regional systems of innovation' has grown rapidly since the middle of the nineties (Cooke, 1996; Maskell and Malmberg, 1997) while Franco Malerba with colleagues developed the concept of 'sectoral systems of innovation' (Breschi and Malerba, 1997). Some of the crucial ideas inherent in the innovation system concept on (vertical interaction and innovation as an interactive process) appear in Porter's industrial clusters as well as in Etzkowitz&Leydesdorff's Triple Helix-concept (Etzkowitz and Leydesdorff 2000)[2].

More representative study the functioning of the national innovation system is a cluster approach.

Clusters are networks of interdependent firms, knowledge-producing institutions (universities, research institutes, technology-providing firms), bridging institutions (e.g. providers of technical or consultancy services) and customers, linked in a production chain which creates added value. The concept of cluster goes beyond that of firm networking, as it captures all forms of knowledge sharing and exchange. The analysis of clusters also goes beyond traditional sectoral analysis, as it takes into account the links to firms outside traditional sectoral boundaries. Cluster analysis is regarded in several OECD countries as an important tool for providing a sound basis for industrial and technology policy. In this respect, cluster analysis is one of the core elements of the work on national innovation systems. Co-operation in clusters is increasingly required for firms to be successful. Moreover, it offers a direct way to improve economic performance and reduce costs. Co-operation can lower costs if firms acquire knowledge and thus meet their needs more cheaply than by producing that knowledge in-house. It also creates greater opportunities for learning, an essential requirement for productivity improvement; it may make possible economies of scale and scope, enable the sharing of risks and R&D costs, and allow greater flexibility. It also may help to reduce the time to market for new products and processes. Analysis of several mature OECD-area industries (textiles, steel and automobiles) suggests that co-operation with suppliers and customers, in increasingly stable arrangements (clusters), has significantly helped these industries to revitalise and regain competitive strength (OECD, 1998a)[3].

Despite Porter's detailed definition of a cluster it is rather difficult to draw clear boarders around a cluster. Porter (1998) himself criticizes aligning clusters in broad groupings, such as manufacturing, consumer goods, or high tech. According to him, discussions about cluster constraints and bottlenecks in such groupings fall into generalities. On the other hand also labeling a single industry as a cluster overlooks crucial cross-industry and institutional interconnections that strongly affect competitiveness. Porter admits that drawing cluster boarders is often a matter of degree. According to him the strength of linkages, their importance to productivity and innovation determine the ultimate boundaries of a cluster. In other words cluster boundaries should encompass all firms, industries, and institutions with strong linkages, whether vertical, horizontal, or institutional; those with weak or non-existent linkages can be safely left out.

According to Davis the cluster approach is feasible for creative industries because it is consistent with the literature that investigates clusters in many other industries and sectors. The key characteristics of clusters remain unchanged despite the industry. These key characteristics are numerous linkages among geographically proximate firms and institutions, especially suppliers, business services, research institutions, and educational institutions. Also Bagwell agrees that the advantages of clustering such as increased competitiveness, higher productivity, new firm

1 Nelson, R. (1993). *National Systems of Innovation: A Comparative Study*. Oxford University Press, Oxford.

2 Porter, M., Stern, S. (2002). *National Innovative Capacity, in World Economic Forum, The Global Competitiveness Report 2001-2002.* Oxford University Press, New York.

3 OECD (2008). *Competitive Regional Clusters.National Policy Approaches, OECD Publications*. Paris.

formation, growth, profitability, job growth and innovation are applicable to creative clusters as well as for other business clusters. The result of these advantages has been that policy makers around the globe have supported clusters as an economic development strategy for various industries and creative industries are no exception. Creative cluster development is now central to the economic strategies of regional development agencies across many regions of the world.

According to the best-known taxonomy of innovating firms, clusters can be categorised as:

1) science-based;

2) scale-intensive;

3) supplierdominated;

4) specialised suppliers[1].

Each type has its own characteristics as regards predominant forms of knowledge flows. For the science-based clusters (e.g. pharmaceuticals, aerospace), direct access to basic research and to public research institutes and universities is important to complement their own research activities. These sectors are highly R&D- and patent-intensive and tend to exhibit closer collaboration with the public research sector. Scale-intensive clusters (e.g. food-processing, vehicles) tend to establish links with technical institutes and universities without performing much research on their own; their innovative performance depends on their ability to import and build upon science developed elsewhere, particularly with regard to process improvements. Supplier-dominated clusters (e.g. forestry, services) tend to import technology mainly in the form of capital goods and intermediary products; their innovative performance is largely determined by their ability to interact with their suppliers as well as extension services. Specialised supplier clusters (e.g. computer hardware and software) are R&D intensive and emphasize product innovations, generally working closely with each other, customers and users.

In studies of national innovation systems, countries have used different approaches to identifying clusters of industries. For the most part, they group sectors according to the intersectoral intensity of different types of knowledge flows, including:

1) embodied technology flows (the purchase of products and intermediate goods from other sectors) and producer-user interactions;

2) technical interactions as measured by the structure of patenting, citations of patents and scientific publications in other sectors, and joint research activities;

3) personnel mobility or the level and flows of skilled workers in and out of sectors.

Countries are increasingly using a “cluster approach” to analysing knowledge flows in national innovation systems in recognition of the close interaction between certain types of firms and industries[2]. These interactions may evolve around key technologies, shared knowledge or skills or producersupplier relationships. Nations, whatever their overall level of innovative performance, do not usually succeed across the whole range of industries, but “in clusters of industries connected through vertical and horizontal relationships” (Porter, 1990). According to the “diamond scheme”, clusters of related and supporting industries can be created through demand patterns for products, rivalry among firms as well as specialised factors or inputs such as skilled personnel or natural resources. Patterns of knowledge flows can differ markedly from cluster to cluster and also within countries specialised around different clusters.

Clusters can be identified at various levels of analysis. Micro-level analysis focuses on inter-firm linkages, industry- (meso-) level analysis on inter- and intra-industry linkages in a production chain, and macro-level analysis on how industry groups constitute the broader economic structure. Cluster analysis can also be applied at the regional level. Regional clusters are often based on

1 Potts, J., Cunningham, S. (2008). Four Models of the Creative Industries. *International Journal of Cultural Policy, 14(3),* 233-247.

2 Roelandt, T. Den Hertog, P. (1999). Cluster Analysis and Cluster- Based Policy Making in OECD Countries: An Introduction to the Theme. *Ch 1 in OECD (“Boosting Innovation: The Cluster Approach*”. Paris: OECD, 9-23.

certain local strengths, such as a strong knowledge infrastructure (possibly linked to the strengths of a local university or research institute), the geographical location or infrastructure (such as the proximity of a major port or airport) or the presence of a major firm. At the aggregate level, most OECD countries for which cluster studies have been made identify certain successful clusters in which these countries possess a strong competitive advantage. For example:

**Australia:** Commercial services, agro-food, metals/electrical, transport and communication, biomedical, ICT.

**Austria:** Construction, chemicals, media, metals/electrical, transport and communication, ICT, wood and paper.

**Belgium:** Energy, ICT, biotechnology, materials. Denmark: Construction, energy, health, agro-food, shipping, technical, pharmaceuticals/bio-technology and medical technology, mink.

**Finland:** Construction, chemicals, energy, health, forestry, basic metals, telecommunications, environment.

**Netherlands:** Construction, chemicals, commercial services, agro-food, energy, health, paper, media, transport and communication, metal/electrical.

**Sweden:** Construction, agro-food, energy, metals/electrical, ICT, wood and paper, materials, machinery, transport equipment.

**United States:** Construction, chemicals, energy, agro-food, media, metal/electrical, ICT, wood and paper, biotechnology, transport equipment, aerospace[1].

Cluster analysis relies on various techniques (input-output analysis, innovation interaction matrices, graph theory, correspondence analysis, case studies), depending on the questions to be addressed. Using these techniques, it is possible to trace the interdependence of firms, which is sometimes based on trade linkages, sometimes on innovation linkages, sometimes on knowledge flow linkages and sometimes on a common knowledge base or common factor conditions. More generally, such studies rely on the idea that innovation is basically an interactive learning process which demands knowledge exchange, interaction and co-operation between various actors in a network of production or value chain.

Today the most popular in cluster system analysis of national innovative systems is the Star–model.

The most distinctive feature of the Star-model is the central role of clusters. The reasons for lifting clusters to the spotlight are clear. According to Porter (1998) clusters represent a new and complementary way of dividing and understanding an economy, organizing economic development thinking and practice, and setting public policy. Also OECD (1997) points out that cluster approach seems to be increasingly popular among innovation system theorists and countries developing innovation policies. There are numerous advantages of cluster approach to innovations. Just for recap a few, benefits of cluster approach consist of overcoming limitations of traditional sectorbased analysis and capturing more fully important linkages both inside the cluster and inside the whole innovation system. Clusters also emphasize cooperation, ease the access for the firms to specialized inputs and promote new business formation in related sectors. All these reasons speak for giving clusters more attention in modeling national innovation system. In addition to raising clusters to the spotlight also other modifications are necessary for the model to be better suited for modern economy. To make the new model take all aspects of economy into account it is very important to avoid the trap of overstressing science and technology. Especially OECD fails to do so by designing its national innovation system –model around a narrow innovation approach, thus neglecting the high innovation potential of other industries, such as creative industries for example. In order to avoid the bias towards science and technology a broader definition of innovation must be used when designing the national innovation system – model. As it was described earlier OECD's model separates a narrow innovation system from a

1 OECD (2008). *Competitive Regional Clusters.National Policy Approaches*. OECD Publications, Paris.

broad one. The Star–model uses a different approach[1]. Here the core of the model consists of innovation cycle and clusters surrounding the innovation cycle. An interrelationship between the core and the rest of the elements included in the model is dependent on boundaries of a cluster. However, drawing cluster boarders is often the matter of degree. Different links are important to different industries and clusters vary in size, breadth and state of development. Some clusters innovations depend highly on linkages to science system (e.g. biotechnology) and some are quite independent of it (e.g. many non-tech sectors). These are the reasons why an unambiguous boundary cannot be drawn between clusters and the rest of national innovation system. Ultimately, the strength of linkages and their importance to productivity and innovation determine the boundaries of a cluster. Thus, drawing boarders between the core of the Star–model and the rest of included elements is possible only in case of a single cluster but this approach cannot be generalized to the model as a whole. Due to these arguments there is no distinction to a narrow and a broad innovation system in the Star–model. Also the role of the state is emphasized in influencing the national innovation system. This feature makes the new model more suitable for countries in the process of transition to knowledge/creative economy and/or countries where the state has a traditionally strong role in the society. Examples of such countries are Russia and China. These distinctive features alter the very core of national innovation system and they have a significant impact on deciding which key elements to include in the national innovation system – model.

The core of the Star–model is innovation cycle surrounded by clusters. The original concept of innovation cycle was developed by OECD. The innovation cycle includes knowledge production – creating and producing knowledge, knowledge application – applying new knowledge to practical solutions in commercial and social terms, and knowledge diffusion – the spread of new knowledge applications across the economy and society until it is absorbed into our evolving way of life.

The rest of the Star–model consists of seven different elements of national innovation system and the state which is given the role of a background actor for the whole national innovation system. The seven elements completing national innovation system are: market conditions, macro- and regulatory environment, education and training, science and research, international network, financing and support organizations, and creative milieu. The state is given separate attention due to its potentially significant influence on every element of national innovation system.

All of these elements can be found in either OECD"s model or in Porter's Diamond model and its later modifications[2]. Several pieces of Porter's competitive view on innovation system are regrouped under one notion of:

- market conditions;
- macro- and regulatory environment;
- science and research;
- education and training;
- international networks;
- financing and support organizations;
- creative milieu.

**Conclusions.** Clusters are engines of innovation, and represent a manageable system for governments to implement the NIS framework by complementing horizontal policies by more targeted and customised policies. The Focus Group on Clusters has provided ample insights on how cluster policy should be part of a wider innovation policy. Its main policy recommendations are the following:

1 Roelandt, T. Den Hertog, P. (1999). Cluster Analysis and Cluster- Based Policy Making in OECD Countries: An Introduction to the Theme. *Ch 1 in OECD "Boosting Innovation: The Cluster Approach".* Paris: OECD, 9-23.

2 Porter, M. (1990). *The Competitive Advantage of Nations, MacMillan*. London.

• Support emerging/existing clusters. Clusters emerge from traditional strengths in the economy or from more random events. The task for governments is to support clusters in their formation and further development. A cluster-based approach to innovation policy is particularly well suited to respond to shocks like major downsizing of large firms and closure of government operations.

• Both macro-level input-output analysis and more micro-level analysis help policy makers identify innovation bottlenecks and missing links in the clusters.

• Avoid high-tech myopia by considering both "low-tech" and "hightech" clusters.

• Assess from a cluster perspective the impact on innovation of a wide range of policies. Evidence shows that defence policy and land-use planning are often driving forces in the formation of clusters.

• Emerging clusters may often benefit from catalytic programmes to stimulate networking, including links with capital markets and business angels.

• The lack of advanced demand is a common bottleneck to cluster development and can justify, for example, specific export programmes and government technology procurement.

Cluster analysis offers other benefits:

• It offers a new way of thinking about the economy and helps overcome the limitations of traditional sectoral analysis.

• It captures important linkages in terms of technology, skills, information, marketing and customer needs, which are increasingly regarded as fundamental to competition and to the direction and pace of innovation.

• It provides ways to redefine the role of the private and public sector and that of other institutions and can provide a starting point for a constructive business-government dialogue.

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