Clusters as Innovative Melting Pots? - the Meaning of Cluster Management for Knowledge Diffusion in Clusters

Jutta Günther, University of Bremen
Dirk Meissner, National Research University – Higher School of Economics Moscow

Corresponding author: Dirk Meissner, Email: d.meissner@hse.ru

Abstract: There is broad consensus that economic development and society welfare correlate with the effectiveness and efficiency of countries' science, technology, and innovation infrastructure. There is a broad range of actors active in all fields with diverging ambitions, missions, and aims striving for scientific, technological, and innovation excellence. Still one actor alone faces severe challenges in the respective global competition which is why increasingly clusters are formed and quipped with professional management. This raises the question if knowledge diffusion channels function more effective and efficient in organically grown self-organized channels or if targeted public policy intervention is needed to enhance these channels by means of attached cluster management. The article discusses the major conceptual features of cluster management and spillovers and the resulting implications for cluster management activities.

Keywords: Cluster, Cluster management, Spillover, Knowledge diffusion

Publication information: The article was published as Günther, J., Meissner, D. Clusters as Innovative Melting Pots?—the Meaning of Cluster Management for Knowledge Diffusion in Clusters. *J Knowl Econ 8, 499–512 (2017)*, DOI: https://doi.org/10.1007/s13132-017-0467-z

Introduction

Achieving sustainable competitiveness of the economies and enhancing quality of life are challenges which require solutions for one of the most difficult social and economic problems—continuous and forward-looking innovation activities in a rapidly changing world. International experience shows that in recent years, innovation policy has taken special account of the innovation profiles' peculiarities in the different parts of the state (regions) and the active involvement of regions in the drafting and implementation of innovation policy (Foray et al. 2009; Camagni and Capello 2013). In this context, clusters, which are typically regionally bound, are playing a more and more important role as they are considered to produce knowledge spillovers which occur in different forms and intensity between cluster participants and also beyond the actual cluster. More and more cluster management is concerned about internationalization issues, including intercluster collaboration. In that perspective, clusters/cluster initiative is seen as instruments to support small- and medium-sized enterprise (SME) internationalization.

This paper will take clusters and cluster policy as a starting point and then discuss cluster management as an important factor to stimulate spillover effects in favor of economic development. This is driven by the conviction that spillovers cannot be managed but that the conditions for spillovers can be shaped. The latter aspect has not been treated strongly in the literature so far but it is crucial for the success and contribution of clusters to economic development. It is our objective to increase the awareness of cluster management as an important factor for the success of cluster activities. The paper will tie in with the existing cluster and spillover literature, discuss the role of cluster management, and draw conclusions also with respect to future empirical work.

As in Europe and in many other countries, in the late 1990s and early 2000s, governments engaged in large scale initiatives for innovation in the economy, including funding and planning support for industrial and innovative clusters. Meissner (2014) describes government's efforts to mobilize regional stakeholders and incorporate them in planning of a strategic vision for the future economic growth (Carayannis et al. 2015; Kindras et al. 2015; Meissner et al. 2016).

Governments adopted innovation as a guide for its policies, introducing bottom-up processes of entrepreneurial discovery to solve the problem of identification, selection, and prioritization in projects to be supported by clusters. Cluster-based smart specialization goes beyond the widespread smart specialization strategies by including a strong implementation element in the specialization strategy discussion. It is a form of fine-tuning priority setting, with localized diagnostic tools and monitoring to gather local market and technology developments and help link them through cluster management to national and global networks.

Although clusters have been studied for years, it is not possible to precisely predict and specify the impact of cluster initiatives on regional development. Clusters typically evolve over a long time; hence, it is almost impossible to assign regional development effects to the original cluster initiative (Schwartz et al. 2012). Clearly, clusters are a somewhat fashionable term used to describe the orchestrated agglomeration of actors in innovation ecosystems, typically in one region or at least in geographic proximity. Such agglomerations have been analyzed frequently (e.g., Boschma and Fornahl 2011) but little work has been done on the actual meaning of cluster management in these agglomerations. The paper therefore provides an analysis and conceptual thoughts of the meaning of cluster management for cluster development with special emphasis on the spillovers occurring from clusters.

The paper will be structured as follows. "Cluster and Cluster Policy" will clarify the expression cluster and cluster policy and define them for the purpose of this paper. In "The Role of Cluster Management," the role of cluster management will be presented in a theoretically based context. "The Meaning of Spillovers for Cluster Management" will shed light on cluster management in support of knowledge spillovers. Finally, "Conclusions" will conclude and discuss future research.

Cluster and Cluster Policy

So far, the term "cluster policy" is frequently used by academics and policy makers with differing meanings. First, clusters are understood as national, regional, or local clusters even in some understandings as a combination of agglomeration of actors at different levels (Aziz and Norhashim 2008). Second, clusters are thought to be central to a range of policy areas, such as science, innovation, regional and industrial development, and SME support. Furthermore, sometimes clusters are considered bottom-up approaches meaning that they evolve and develop organically but also top-down approaches exist which impose the formation of clusters at all levels mainly to serve an overarching national interest. Accordingly, cluster policies involve a broad range of policy instruments, which can be considered elements of science, technology, and innovation (STI), but especially innovation policy (Meissner 2015; Salonius and Käpylä 2013; Carayannis et al. 2016; Covi 2016).

Still, the challenge remains that no commonly accepted and shared understanding and definition of STI policy exists, which makes it even more difficult to precisely describe cluster policies or cluster policy. There is a difference between cluster policy and cluster policies in the authors' understanding. A single cluster policy is meant to involve a range of policy instrument each being part of another overarching policy field, for example, R&D or innovation-related tax incentives as an instrument of tax policy or measures to enable diffusion of human resources between academic and industrial research as an instrument of science policy and innovation policy. Cluster policies are meant policy measures to support cluster initiation and operation which are embedded under the umbrella of an overarching national or regional cluster policy.

The establishment and organization of clusters are frequently assumed an effective and efficient mechanism to enhance industries' and thereby regions' and nations' competitiveness. Skokan (2005) finds that clusters are frequently assigned a role for industrial development, innovation, and resulting regional competitiveness and growth. The underlying rational is found in market failures blocking innovation process and therefore justifying government involvement. The latter is pictured in the triple helix thinking (Leydesdorff and Etzkowitz 2000), which imposes a strong emphasis on the interaction between companies, research institutions, and governments at different levels and in different shapes. In a similar understanding, clusters are geographic concentrations of companies and non-business institutions in a particular field (Lundvall and Borras 1997; Porter 2000; Mills et al. 2008). The relationships between cluster actors can be of cooperative but also of competitive nature (Johannisson et al. 2007). In principle, clusters are voluntary assemblies in an "association style," which bring together actors with different backgrounds and ambitions but overarching similar visions and needs (Johannisson and Lindholm Dahlstrand 2009; Moss 2009; Carayannis and Borowik 2010).

Clusters are initiated and supported with the aim of generating different positive externalities for its "residents" including reduced transportation and production costs and access to common infrastructure and labor market (Kutsenko and Meissner 2013; Makarov et al. 2016). The stronger established clusters often attract foreign investors with the objective to engage in related technological activities and looking for complementary cooperation partners (Dettmann et al. 2015). Foreign investors often look for tacit knowledge cluster participants possess with the obvious aim of benefiting from this. The latter occurs through direct and personal interaction for which clusters by means of network relationships with other member organizations, e.g., by means of knowledge and information exchange provide good platforms (Groen et al. 2008; Johannisson et al. 2002; Johannisson and Lindholm Dahlstrand 2009; Bienkowska et al. 2011; Kutsenko 2015; Zemtsov et al. 2016). Cluster policies consequently aim at institutionalizing, formalizing, and improving these relationships in different ways (Ahedo 2004; Mattsson 2009; Hassen et al. 2011.

Laur et al. (2012) propose to consider clusters as matchmakers bringing together different stakeholders (actors). First, they distinguish between key players who are influential in providing resources, show dominance in developing strategies and agendas, and have long-term commitment. Second, they argue

that target groups are involved, which are essential for detecting the actual demand for communication and exchange, and third, they assign support groups which contribute via grown networks and influence on different stakeholders. The structural cluster design needs to be fine-tuned to the respective region-specific characteristics including business structures, national-regional-cross-border clusters, clusters of competence, industrial or production systems, and innovation systems. In addition, the goals underlying cluster initiatives vary reasonably including goals such as a dedicated increase of regional SME competitiveness, support of collective research, and reshaping regional industries. Literature and practical applications share an understanding that clusters are characterized by regional proximity, networking, and specialization (Skokan 2005).

More than a decade ago in his seminal work, Porter (2000) proposed a frequently quoted cluster definition that considers especially geographic proximity of organizations, e.g., companies, institutions, and associations which feature common and complementary characteristics and which organized themselves in different forms. Accordingly, the geographic scope of clusters is not necessarily bound to a municipality, region, or country but can cross borders, particularly in border regions. Further important features to characterize clusters are the vertical and horizontal integration and interaction of cluster participants (Maskell 2001a, b; Malmberg and Maskell 2002; Bathelt and Taylor 2002).

Vertical integration mainly refers to the value chain integration, e.g., supplier-customer relationships between different actors (companies, service providers but also universities and research institutes) while the horizontal dimension features competing organizations with at least similar targets or market segments. Thus, the latter is featured by a competition dimension between the organizations, which can also be considered a driving force for vertical integration triggering cooperation activities of organizations but also allowing learning from each others' activities in the form of benchmarking and creates strong awareness for differentiation of the organizations products and services. In order to achieve lasting impact from these activities—mainly in the horizontal dimension—the tacit knowledge component and the surrounding socioeconomic and socio-institutional framework are important, because they can take a supporting or blocking role for communication and interaction between organizations (Maskell et al. 1998; Gordon and McCann 2000; Bathelt and Glückler 2002).

To sum up, we can distinguish from a conceptual point of view cluster, cluster policy, and cluster management. Cluster will be defined in our paper as a group of interconnected actors that are geographically closely located working towards a common goal. As a common goal, we will focus on innovation in this paper. Cluster policy is the support of public authorities across different fields of activity (e.g., production, innovation, education) to a cluster as defined above. Cluster management is all organizational and managerial work within a cluster that contributes to improved interconnectedness between cluster members (internal relations) and between the cluster and surrounding actors (external relations). In the following, we will deeper analyze and discuss the meaning of cluster management.

The Role of Cluster Management

Clusters are typically formally organized networks in different forms. They can take the form of legal entities but also loose associations. Frequently, clusters employ a cluster manager and run a cluster office or similar, which is coordinating the cluster, initiates activities, and provides support to members and external relations with other partners. The internal cluster management activities are characterized by a strong focus on value delivered to the members. Thus, cluster management provides a professionally organized spectrum of services to its members including research and innovation co-operations and ventures, technology and knowledge transfer services, manufacturing and marketing alliances, staff exchange, and other related means which was found as early as 1995 by Liyanage (1995). Cluster management thus takes a mainly initiating and coordinating role instead of being actively involved in the subject and activities of the cluster participants as such (Carayannis and Meissner 2016; Cervantes 2016; Glückler and Armbrüster 2003).

If large and financially strong players are involved in a cluster, the existence of a professional cluster management is more or less self-evident because it is often driven and established by these companies. But if it comes to clusters which bring together small and medium players, almost exclusively it appears that these often are challenged raising the resources necessary to install a cluster management. In such cases, the role of cluster policy is particularly crucial. The role of the government (public authorities) can then be to enable an emerging cluster to professionalize and gain strength, especially in the early stage. The public support of cluster management can play an important role and is often subject to cluster policy tools. Among the many important factors for the development and growth of clusters, the personal direct interaction of individuals in geographic proximity is especially relevant, even in times of modern information and communication technologies. This is shown in various studies on different industries, e.g., Zucker et al. and Feldman showed the impacts for biotechnology (Feldman 2003), Pinch, Henry and Almeida, Kogut for motor sport and semiconductor industry (Almeida and Kogut 1999), Fallick et al. for Silicon Valley computer industry (Fallick et al. 2006), and Niosi and Zhegu for aerospace industry (Niosi and Zhegu 2005). It should be noted that clusters have certainly an immediate impact on participants' innovation activities but the time frame for such impacts to occur is long term rather than short term. Another dimension is clusters themselves, e.g., the agglomeration of companies in geographical region or industrial sectors and the related research institutions in corresponding or complementary fields.

Developing clusters depends not only on professional management and targeted cluster offices but is also determined by the regional distribution of participants and the communication behavior of participants within the network. Development and operation of clusters thus are often challenged by institutional constraints arising from cluster members' intentions, rules, and attitudes. In other words, the internal innovation culture of cluster participants is one of the driving factors for breeding clusters. Another important determinant is the respective regulations imposed by the legal environment with impact on spin-off creation from public research and higher education institutions but also companies, institutional rules for collaborative activities, joint ventures, and mergers to name the most important (Liyanage 1995).

Malberg and Maskell (1997) argued that companies are sharing knowledge in the clusters which leads to the creation of a shared knowledge base which in turn takes the function of the base for recombining knowledge elements to create new solutions. While there is the frequently cited argument that the availability and instant accessibility of codified knowledge drives innovation, the challenge remains to filter the important and relevant share from the available stock of information to avoid information overflow (Goulding 2001). Through a significant number of individuals being confronted with this challenge, the information stock is under respective evaluation and assessment from different perspectives. Furthermore, cluster participants often recommend information sources or provide information informally, which is in the long term a guarantee for the belief of individuals in the quality of information before they transmit or recommend to others. The reason is that the reputation of individuals is very likely to suffer substantially if poor quality information is transmitted.

In principle, codified knowledge is available to a broad and global audience at any time at the comparably modest cost provided that information and communication infrastructures are in place and that absorptive capacity is given. However, available codified knowledge does not provide readymade solutions, which can be directly incorporated in technological solutions and innovations (Bathelt et al. 2004). In this sense, codified knowledge frequently requires tacit knowledge and peoples' skills to be used for dedicated purposes. Among these skills are competences for identifying, assessing, and absorbing, in other words transforming existing knowledge into new applications (Maskell 2001a, b; Asheim 1999). The latter also includes the definition and description of interfaces to other solutions, which in sum form the final technological solution or significant parts of it.

There has been sufficient discussion of the potential of cluster organizations to enable knowledge exchange between different parties at reasonable cost which eventually lead to significant growth within the cluster, e.g., economic growth by cluster participants supported by accessing organizations'

external sources of knowledge (Liyanage 1995). This argument is frequently quoted in the literature about industrial districts (e.g., Pyke et al. 1990), innovative milieus (Camagni 1991; Ratti et al. 1997), and transaction cost-based analyses (e.g., Cheng 2010). In this regard, the challenge arises to define the role and duties for cluster management which supports the growth expectations. It needs to be stressed again that clusters alone do not generate growth and development, but their role is more or less limited to take an inspiring and supporting role. This makes it eventually difficult to determine the real impact of cluster management on cluster members' economic development (causality problem). In addition, cluster organizations do not have a regional impact only but contribute to some extend to the reputation and image of the region cluster participants that are located, thus providing intangible support for cluster members by reputation (Humphrey and Schmitz 2002). Although there is hardly any doubt about this impact of clusters on its members, it is hard to quantify.

Exchange of information and knowledge among cluster participants is one major step in the evolution of more formalized cooperative undertakings involving all cluster members. Especially information exchange is not limited to exchange of technical-related or directly innovation-related information but instead involves a reasonable share of small talk and less formal information (Gertler 1993). Such a form of communication is observed frequently and arguably among the important factors for building lasting trust among individuals among other possible impacts. Diffusion of these types of information depends strongly on the individuals involved; hence, it can hardly be generalized. In some clusters, this form of communication might appear more frequently than in others and also it depends on the information itself (Bathelt and Glückler 2002). However, the general features of this communication are increased speed of communication and the spontaneous appearance thus non-targeted and accidental eventually building trust and empathy among the individuals involved. Personal relations, which emerge from this basis, often demonstrate a supporting contribution to the building of relations between organizations by means of door opener or supporter within organizations. Furthermore, personal relations have an impact on learning processes within the clusters and support the exchange and movement of people hence competences and skills and competences which are not available at certain organizations and require more substantial investment to develop (Almeida and Kogut 1999; Møen 2001; Nonaka et al. 2000; Rosenkopf and Almeida 2001; Bellantuono et al. 2013; Botsaris and Vamvaka 2016; Echajari and Thomas 2015; Gokhberg et al. 2016; Paraponaris and Sigal 2015; Haas 2015; Sum and Jessop 2013). The geographic proximity together with these forms of communication behavior forms a strong supporter effect towards regional specific understanding and the emergence of respective ecosystems (Lawson and Lorenz 1999; Maskell et al. 1998; Wenger 1998). It appears that cluster participants through their institutional engagement and the personal relationships (networks) develop and maintain linkages also through shared experiences and a common understanding of technologies, which makes it easier to extend networks across the value chain in a sense of horizontal integration (Gertler 2003). Hence, clusters may take a function as catalysts for these communications by providing incentives to and a supportive environment to communicate.

Recent experience provides evidence that a professional management has a positive role to develop and keep a cluster. The cluster management has seldom a clearly defined role in the network but needs to find his role to become a respected actor who is supported by cluster participants (Jones-Evans et al. 1999; Klofsten et al. 2015). Cluster management often develops its own communication systems targeted at supporting the information and communication flow between cluster members (Breschi and Lissoni 2003). However, these do not focus on the communication within the cluster but also with other stakeholders and related ecosystems (Klofsten and Jones-Evans 1996; Sölvell 2009; Kenney 2000; Klofsten et al. 2015). Cluster management in different organizational setups is contributing significantly to cluster development through its activities and services provided to cluster members (Moss 2009). It is important though that these activities are in-line with the actual participant demands and needs; thus, multiple different "clients" (in sense of cluster participants) needs have to be fulfilled. Thus, cluster management has a strong mediation role between the different actors which comes close to the triple helix thinking and understanding (Laur et al. 2012; Klofsten et al. 2015; Tödtling et al. 2013).

Although the so defined and described success factors are rather broad, they might serve cluster management to some extend as cornerstones for developing activities and supporting cluster development. In this regard, the challenge arises, what kind or activities cluster management might offer to cluster participants which are not provided commercially already and which features these activities show. One important feature of cluster management is that the activities and services provided need to be balanced between services for cluster participants only and services open to other interested parties. Cluster internal services are usually characterized by a certain degree of confidentiality of information which are exchanged by participants and stored for cluster internal purposes only. Moreover, cluster management is barely considered a commercial undertaking but a mediator and initiator of continuous activities which members would not use on a commercial base for several reasons. Among these reasons are transaction cost affiliated to such services which occur when a company starts screening potential suppliers for related services and the less frequent use of such services paired with the relatively small fees which would occur. Thus, these services are a kind of services shared by cluster participants with "sharing" referring to use and finance of services (Etzkowitz 2002; DTI 2004).

The Meaning of Spillovers for Cluster Management

It is believed that clusters are supporting the generation of spillovers in different shapes which eventually leads to innovation and economic development. Such spillovers occur between actors of a cluster almost naturally. The intention of cluster policies is the orchestration and stimulation of these spillovers. However, clusters alone do not necessarily generate innovation in the broader sense but it seems likely that clusters grow around a knowledge base generating even more new knowledge which is not necessarily transformed into innovation at the same location. Also in practice, there might be lock-in effect with clusters; furthermore, cluster management could play a role of lobbing current industries and technologies. That is the reality which is well understood but not studied enough. Spillovers within clusters can take a broad range of forms and directions (Table 1).

Table 1 Spillover taxonomy

Direction	*Horizontal*	*Vertical*
	Exchange between people and institutions at same level	Exchange between different levels of the value chain
Organization	*Intra-organizational*	*Inter-organizational*
	Within organization based in cluster	Between organizations based in cluster
Interaction	*Direct*	*Indirect*
	No third party involved	Facilitator, cluster member involved
Process	*Technology push*	*Demand pull*
	Spill-over existing knowledge	Search for new solutions for given challenge
Adaptation	*Imitation*	*Adaptation*
	Direct transfer without technical adoption	Adapted solution according to users requirements

Source: Meissner (2012)

Horizontal spillovers mean the exchange between individuals or institutions at the same level or market segment. Vertical knowledge and technology spillovers take place mainly in various stages of the innovation process, i.e., between providers (scientists, universities, research institutes, etc.) and recipients (e.g., businesses, social institutions) of knowledge and technology. However, it is possible that individual stages of the innovation process can be skipped. This is particularly important for small- and medium-sized enterprises (SMEs), in which R&D and innovation activities due to a lack of resources are limited (Proskuryakova et al. 2016; Schibany and Reiner 2014). To capture vertical knowledge, clusters normally include actors which play different roles in the innovation process: large companies, SMEs, universities and scientific organizations, governmental agencies, and infrastructure organizations (technology parks, business incubators, technology transfer centers, industrial design centers, etc.).

Inter-organizational spillovers are the external sourcing and/or exploitation of knowledge and technology especially by companies. This is an essential part of technology and innovation management when converting inventions generated from institution's explorative and R&D activities into innovation within an organization whereas intra-organizational spillovers are mainly an issue of company innovation management. Furthermore, structured hierarchical levels of institutions engaged in spillovers play an important if not a crucial role.

Spillovers occur directly or indirectly. Direct spillovers mean that know-how and/or technology from inventing entities are transferred to recipients on their initiative and do not require support of technology intermediaries. Indirect spillovers are the mediated transfer of opportunities involving one or more intermediaries. Clusters play an important role for indirect spillovers, e.g., spillovers from current R&D to future R&D activities. These spillovers can be traced back to the knowledge generation process, e.g., knowledge and competences resulting from R&D activities are commonly used for further application in the form of tacit or codified knowledge. In this way, cluster-based R&D activities generate spillovers which contribute substantially to generating new knowledge, which in turn eventually enhances local innovators' absorptive capacity to take advantage of external technology and innovation. This affects not only R&D prospects of cluster-based companies but also the future R&D of external companies. Consequently, such spillovers are realized not only by external companies but also research institutes and education institutions which in the long term contributes to the attractiveness of clusters since cluster members and external actors realize the resulting effects. However, this is a long-term effect which so far cannot be measured reliably.

Technology-push spillovers mean the transfer of existing technical know-how and technologies to new fields and applications. Otherwise, possible solutions to a given problem, in the form of new technologies, sought from other areas, constitute demand-driven spillovers. The initiative of transfer is through a direct transfer, without any technical adaptation of the absorbing organization (imitation), i.e., the technology is used one to one. Hence, it is merely a "relocation," while in case of adaptive spillovers, further activities are required to customize the application of new knowledge to the specific needs and circumstances of the recipient.

Knowledge spillovers are among the positive externalities and nowadays are becoming important motivations for the establishment of clusters (Cervantes and Meissner 2014). Knowledge spillovers per se are often spillovers of tacit knowledge, e.g., the exchange of personalized information (experience, latest news, etc.) between individuals which differs significantly from the exchange of codified knowledge. Such interaction typically requires confidence and trust between the individuals which is mainly built and generated through direct personal interactions (Zaytseva et al. 2013). Clusters at the same time aim strongly at the interaction of individuals hence the exchange of tacit knowledge. Thus, clusters and networks are important measures and channels for the diffusion of tacit knowledge. This raises the question if such knowledge diffusion channels are more effective and efficient as organically grown self-organized channels or if targeted public policy intervention is needed to enhance these channels (Cooke and Huggins 2003; Ketels and Memedovic 2008). Another line of thinking is that public policy intervention by means of cluster policy can improve the

interaction of existing self-organized clusters through various measures such as education and training infrastructures, procurement of local innovation, or adjusting regulations imposed by governmental bodies (Laur et al. 2012). In this light, the question arises which activities should be central to clusters and how the portfolio of cluster activities should be balanced. It appears that clusters need to balance activities which aim at short-term impact to satisfying the current needs of cluster participants but it also has to elaborate potential future demand of current cluster members and to identify future members and their respective anticipated needs (Brown 2000; Teigland and Lindqvist 2007; Klofsten and Jones-Evans 1996). Such an approach requires the involvement of a broader audience than current cluster members with the rational being to create sustainable momentum and allow participants to enter new grounds which arise from so far unknown exchanges of fully different experiences and views. Naturally, this requires reasonable openness of the cluster participants in expressing their own views but also in respecting and considering other's views. In this regard, clusters are at least partially institutionalized "open innovation melting pots" which should serve the purpose of early changing need detection and the preparation of participants to developing responses to changing environments. In such way, clusters can be viewed as entrepreneurs within a business, science, and government community regardless if the entrepreneurial spirit comes from private actors, public bodies, or both (Klofsten and Jones-Evans 1996; Lundequist and Power 2002; Ketels and Memedovic 2008; Macdonald 2007).

Conclusions

Clusters gained much importance over the last decades, and policy makers put much emphasis on public support of cluster initiatives. Mostly, clusters are associated with regional or local development and often emerge within a particular technological or industrial field. They are a real example of cross-cutting policy task, and many efforts have been undertaken to further develop suitable concepts for cluster policy. Mostly, clusters are associated with innovation activities to take place. Therefore, this paper focused on knowledge (technology) spillovers as a crucial aspect for successful clusters. Clusters in the authors' view can be looked at as innovative melting pots, i.e., a conglomerate of different actors which dynamically develop themselves and with them the cluster as such.

One aspect that has been paid less attention to in the literature so far is the role of cluster management. While it is widely acknowledged that a professional cluster management is needed both in the early and also in the mature stage of a cluster, there seems to be a lack of theoretical concepts and empirical studies about the role and impact of cluster management. Future research, especially empirical work, should develop concepts to measure the quality of cluster management and relate it to performance indicators. In a first step, qualitative empirical work would be valuable before making attempts to use standardized characteristics.

Last but not least, any cluster strategy and cluster management must be context specific. Emerging economies and structurally weak regions face different challenges than technologically advanced and highly industrialized countries. The question what emerging countries can learn and what they should avoid looking at more advanced countries is also subject to future policy oriented research.

Acknowledgements

The article was prepared within the framework of the Basic Research Program at the National Research University Higher School of Economics (HSE) and supported within the framework of the subsidy granted to the HSE by the Government of the Russian Federation for the implementation of the Global Competitiveness Program.

References

Ahedo, M. (2004). Cluster policy in the Basque Country (1991-2002): Constructing industry government' collaboration through cluster-associations. European Planning Studies, 12(8), 1097–1113.

Almeida, P., & Kogut, B. (1999). Localization of knowledge and the mobility of engineers in regional networks. Management Science, 45(7), 905–917.

Asheim, B. (1999). Interactive learning and localised knowledge in globalizing learning economies. GeoJournal, 49, 345–352.

Aziz, K., & Norhashim, M. (2008). Cluster-based policy making: Assessing performance and sustaining competitiveness. Review of Policy Research, 25(4), 349–375.

Bathelt, H., Malmberg, A., & Maskell, P. (2004). Clusters and knowledge: local buzz, global pipelines and the process of knowledge creation. Progress in Human Geography, 28(1), 31–56.

Bathelt, H., & Glückler, J. (2002). Wirtschaftsgeographie: Ökonomische Beziehungen in räumlicher Perspektive (Economic geography: economic relations in spatial perspective). Stuttgart: UTB-Ulmer.

Bathelt, H., & Taylor, M. (2002). Clusters, power and place: inequality and local growth in timespace. Geografiska Annaler, 84B, 93–109.

Bellantuono, N., Pontrandolfo, P., & Scozzi, B. (2013). Different practices for open innovation: a context-based approach. Journal of Knowledge Management, 17(4), 558–568.

Bienkowska, D., Lundmark, M., & Malmberg, A. (2011). Brain circulation and flexible adjustment: labour mobility as a cluster advantage. Geografiska Annaler: Series B, Human Geography, 93(1), 21–39.

Boschma, R., & Fornahl, D. (2011). Cluster evolution and a roadmap for future research. Regional Studies, 45(10), 1295–1298.

Botsaris, C., & Vamvaka, V. (2016). Attitude toward entrepreneurship: structure, prediction from behavioral beliefs, and relation to entrepreneurial intention. Journal of the Knowledge Economy, 7, 433. doi:10.1007/s13132-014-0227-2.

Breschi, S., & Lissoni, F. (2003). Mobility and social networks: localised knowledge network spillovers revisited. Milan: CESPRI (Centro di Ricercasui Processi di Innovazione e Internazionalizzazione).

Brown, R. (2000). Cluster dynamics in theory and practice with application to Scotland, regional and industrial policy research paper no 38. Glasgow: European Policies Research Centre, University of Strathclyde.

Camagni, R. (1991). Innovation networks: spatial perspectives. London and New York: Belhaven Press.

Camagni, R., & Capello, R. (2013). Regional innovation patterns and the EU regional policy reform: toward smart innovation policies. Growth and Change, 44(2), 355–389.

Carayannis, E., & Borowik, I. (2010). Forms and role of cluster initiatives in fostering innovation in post-industrial regions: a comparative study of environmental technologies clusters in the British West Midlands and the Spanish Basque Country. International Journal of Innovation and Regional Development, 3(3–4), 222–253.

Carayannis, E. G., & Meissner, D. (2016). Glocal targeted open innovation: challenges, opportunities and implications for theory, policy and practice. The Journal of Technology Transfer, 2016. doi:10.1007/s10961-016-9497-0.

Carayannis, E. G., Meissner, D., & Edelkina, A. (2015). Targeted innovation policy and practice intelligence (TIP2E): concepts and implications for theory, policy and practice. The Journal of Technology Transfer. doi:10.1007/s10961-015-9433-8.

Carayannis, E., Grebeniuk, A., & Meissner, D. (2016). Smart roadmapping for STI policy. Technological Forecasting and Social Change, 110, 109–116.

Cervantes M. (2016). Higher education institutions in the knowledge triangle. Foresight and STI Governance 10(4)

Cervantes, M., & Meissner, D. (2014). (2014). Commercialising public research under the open innovation model: new trends. Foresight and STI Governance., 8(3), 70–81.

Cheng, A. L. (2010). Foresight mechanism for policy coordination: some explanations based on transaction-cost view within knowledge networks. International Journal of Foresight and Innovation Policy, 6(1–3), 66–78.

Cooke, D., & Huggins, R. (2003). High-technology clustering in Cambridge (UK). In F. Sforzi (Ed.), The institutions of local development (pp. 51–74). Aldershot: Ashgate Publishing.

Covi, G. (2016). Local systems' strategies copying with globalization: collective local entrepreneurship. Journal of the Knowledge Economy, 7, 513. doi:10.1007/s13132-014-0225-4.

Dettmann, E., Dominguez, L., Günther, J., & Jindra, B. (2015). The importance of localized related variety for international diversification of corporate technology. Regional Studies, 50(10), 1648–1662.

DTI. (2004). Practical guide to cluster development, report to the Department of Trade and Industry and the English RDAs by Ecotec Research & Consulting. London: DTI.

Echajari, L., & Thomas, C. (2015). Learning from complex and heterogeneous experiences: the role of knowledge codification. Journal of Knowledge Management, 19(5), 968–986.

Etzkowitz, H. (2002). MIT and the rise of entrepreneurial science. London: Routledge.

Fallick, B., Fleischman, C. A., & Rebitzer, J. B. (2006). Job-hopping in Silicon Valley: some evidence concerning the microfoundations of a high-technology cluster. The Review of Economics and Statistics, 88(3), 472–481.

Feldman, M. (2003). The locational dynamics of the US biotech industry: knowledge externalities and the anchor hypothesis. Industry and Innovation, 10(3), 311–329.

Foray, D., David, P. A., & Hall, B. (2009). Smart specialisation–the concept. Knowledge Economists Policy Brief, 9(85), 100.

Gertler, M. S. (1993). Implementing advanced manufacturing technologies in mature industrial regions: towards a social model of technology production. Regional Studies, 27, 665–680.

Gertler, M. S. (2003). Local knowledge: tacit knowledge and the economic geography of context, or the undefinable tacitness of being (there). Journal of Economic Geography, 3, 75–99.

Glückler, J., & Armbrüster, T. (2003). Bridging uncertainty in management consulting: the mechanisms of trust and networked reputation. Organization Studies, 24, 269–297.

Gokhberg, L., Meissner, D., & Shmatko, N. (2016). Myths and realities of highly qualified labor and what it means for PhDs. Journal of the Knowledge Economy. doi:10.1007/s13132-016-0403-7.

Gordon, I. R., & McCann, P. (2000). Industrial clusters: complexes, agglomeration and/or social networks. Urban Studies, 37, 513–532.

Goulding, A. (2001). Information poverty or overload? Journal of Librarianship and Information Science, 33(3), 109–111.

Groen, A., Van Der Sijde, P., & Walsh, S. (2008). Introduction: entrepreneurship's role in commercializing disruptive technologies. International Small Business Journal, 26(1), 5–7.

Haas, A. (2015). Crowding at the frontier: boundary spanners, gatekeepers and knowledge brokers. Journal of Knowledge Management 2015, 19(5), 1029–1047.

Hassen, T. B., Klein, J., & Tremblay, D.-G. (2011). Building local nodes in a global sector: Clustering within the aeronautics industry in Montreal. Canadian Geographer/Le Géographe Canadien, 55(4), 439–456.

Humphrey, J., & Schmitz, H. (2002). How does insertion in global value chains affect upgrading in industrial clusters? Regional Studies, 36, 1017–1027.

Johannisson, B., & Lindholm Dahlstrand, Å. (2009). Bridging the functional and territorial rationales—proposing an integrating framework for regional dynamics. European Planning Studies, 17(8), 1117–1133.

Johannisson, B., Ramírez-Pasillas, R., & Karlsson, G. (2002). The institutional embeddedness of local inter-firm networks: a leverage for business creation. Entrepreneurship & Regional Development, 14(4), 297–315.

Johannisson, B., Caffarena, L., Cruz, A., Epure, M., Pérez, E., Kapelko, M., Murdock, K., Nanka-Bruce, D., Olejárová, M., Lopez, A., Sekki, A., Stoian, M.-C., Tötterman, H., & Bisignano, A. (2007). Understanding the industrial district: contrasting conceptual images as a road to insight. Entrepreneurship & Regional Development, 19(6), 527–554.

Jones-Evans, D., Klofsten, M., Andersson, E., & Pandya, D. (1999). Creating a bridge between university and industry in small European countries: the role of the industrial liaison office. R & D Management, 29(1), 47–56.

Kenney, M. (2000). Introduction. In M. Kenney (Ed.), Understanding Silicon Valley: the anatomy of an entrepreneurial region (pp. 1–14). Stanford: Stanford University Press.

Ketels, C., & Memedovic, O. (2008). From clusters to cluster-based economic development. International Journal of Technological Learning, Innovation and Development, 1(3), 375–392.

Kindras, A., Meissner, D., & Vishnevskiy, K. (2015). Regional foresight for bridging national science, technology, and innovation with company innovation: experiences from Russia. Journal of the Knowledge Economy. doi:10.1007/s13132-015-0296-x.

Klofsten, M., & Jones-Evans, D. (1996). Stimulation of technology-based small firms—a case study of university-industry cooperation. Technovation, 16(4), 187–213.

Klofsten, M., Bienkowska, D., Laur, I., & Sölvell, I. (2015). Success factors in cluster initiative management. Industry & Higher Education, 29(1), 65–77.

Kutsenko, E. (2015). Pilot innovative territorial clusters in Russia: a sustainable development model. Foresight and STI Governance., 9, 32–55.

Kutsenko E. S., Meissner D. (2013). Key features of the first phase of the National Cluster Programme in Russia / NRU Higher School of Economics. Series WP BRP. Science, Technology and Innovation. 2013. No. 11/STI/2013.

Laur, I., Klofsten, M., & Bienkowska, D. (2012). Catching regional development dreams: a study of cluster initiatives as intermediaries. European Planning Studies, 20(11), 1909–1921.

Lawson, C., & Lorenz, E. (1999). Collective learning, tacit knowledge and regional innovative capacity. Regional Studies, 33(4), 305–317.

Leydesdorff, L., & Etzkowitz, H. (2000). The dynamics of innovation: from national systems and mode 2 to a triple helix of university-industry-government relations. Research Policy, 29, 111.

Liyanage, S. (1995). Breeding innovation clusters through collaborative research networks. Technovation, 15(9), 553–567.

Lundequist, P., & Power, D. (2002). Putting porter into practice? Practices of regional cluster building: evidence from Sweden. European Planning Studies, 10(6), 685–704.

Lundvall, B.-Å., & Borras, S. (1997). The globalising learning economy: implications for innovation policy (p. 2009). Brussels: European Commission Mattsson.

Macdonald, R. (2007). Beat the system: 11 secrets to building an entrepreneurial culture in a bureaucratic world. London: Wiley.

Makarov, V., Ayvazyan, S., Afanasyev, M., Bakhtizin, A., & Nanavyan, A. (2016). Modeling the development of regional economy and an innovation space efficiency. Foresight and STI Governance, 10(3), 76–90. doi:10.17323/1995-459X.2016.3.76.90.

Malmberg, A., & Maskell, P. (1997). Towards an explanation of industry agglomeration and regional specialization. European Planning Studies, 5, 25–41.

Malmberg, A., & Maskell, P. (2002). The elusive concept of localization economies: towards a knowledge-based theory of spatial clustering. Environment and Planning A, 34, 429–449.

Maskell, P. (1998). Low-tech competitive advantages and the role of proximity: the Danish wooden Furniture industry. European Urban and Regional Studies, 5(2), 99–118.

Maskell, P. (2001a). Towards a knowledge-based theory of the geographical cluster. Industrial and Corporate Change, 10, 921–994.

Maskell, P. (2001b). Knowledge creation and diffusion in geographic clusters. International Journal of Innovation Management, 5(2), 213–237.

Mattsson, H. (2009). Innovating in cluster/cluster as innovation: the case of the biotech valley cluster initiative. European Planning Studies, 17(11), 1625.

Meissner, D. (2012). The economic impact of spillovers from R&D and Innovation. ФОРСАЙТ, 12(4), 29.

Meissner, D. (2014). Approaches for developing national STI strategies. STI Policy Review, 5(1), 34–56.

Meissner, D. (2015). Public-private partnership models for science, technology, and innovation cooperation. Journal of the Knowledge Economy. doi:10.1007/s13132-015-0310-3.

Meissner, D., Polt, W., & Vonortas, N. S. (2016). Towards a broad understanding of innovation and its importance for innovation policy. The Journal of Technology Transfer. doi:10.1007/s10961-016-9485-4.

Mills, K., Reynolds, E., & Reamer, A. (2008). Clusters and competitiveness: a new federal role for stimulating regional economies. Washington, DC: The Brookings Institution.

Møen, J. (2001). Is mobility of technical personnel a source of R&D spillovers? Washington, DC: National Bureau of Economic Research (NEBR) Report 7834.

Moss, T. (2009). Intermediaries and the governance of sociotechnical networks in transition. Environment and Planning, 41(6), 1480–1495.

Niosi, J., & Zhegu, M. (2005). Aerospace clusters: local or global knowledge spillovers? Industry & Innovation, 12(1), 5–29.

Nonaka, I., Toyama, R., & Nagata, A. (2000). A firm as a knowledge-creating entity: a new perspective on the theory of the firm. Industrial and Corporate Change, 9, 1–20.

Paraponaris, C., & Sigal, M. (2015). From knowledge to knowing, from boundaries to boundary construction. Journal of Knowledge Management, 19(5), 881–899.

Porter, M. (2000). Location, competition, and economic development: local clusters in a global economy. Economic Development Quarterly, 14(1), 15–34.

Proskuryakova, L. N., Meissner, D., & Rudnik, P. B. (2016). The use of technology platforms as a policy tool to address research challenges and technology transfer. The Journal of Technology Transfer, 41(5), 1–22.

Pyke, F., Becattini, G., & Sengenberger, W. (1990). Industrial districts and interfirm cooperation in Italy. Geneva: International Institute for Labour Studies.

Ratti, R., Bramanti, A., & Gordon, R. (1997). The dynamics of innovative regions: the GREMI approach. Aldershot and Brookfield: Ashgate.

Rosenkopf, L.; Almeida, P. (2001). Who's building on whom? Overcoming localization biases through alliances and mobility. In: Academy of Management Proceedings (Vol. 2001, No. 1, pp. E1-E6). Academy of Management.

Schibany, A., & Reiner, C. (2014). Can basic research provide a way out of economic stagnation? Foresight-Russia, 8(4), 54–63.

Schwartz, M., Peglow, F., Fritsch, M., & Günther, J. (2012). What drives innovation output from subsidized R&D cooperation? Project-level evidence from Germany. Technovation, 32(6), S358–S369.

Skokan, K. (2005). Financing cluster initiatives. Econ ´05 (selected research papers), Technical University of Ostrava, Faculty of Economics 12:317–324. ISSN 0862–7908.

Sölvell, O. (2009). Clusters: balancing evolutionary and constructive forces. Stockholm: Ivory Tower AB.

Sum, N., & Jessop, B. (2013). Competitiveness, the knowledge-based economy and higher education. Journal of the Knowledge Economy, 4, 24. doi:10.1007/s13132-012-0121-8.

Teigland, R., & Lindqvist, G. (2007). Seeing eye-to-eye: how do public and private sector views of a biotech cluster and its cluster initiative differ? European Planning Studies, 15(6), 767–786.

Tödtling, F., Skokan, K., Höglinger, C., Rumpel, P., & Grillitsch, M. (2013). Innovation and knowledge sourcing of modern sectors in old industrial regions: comparing software firms in Moravia–Silesia and Upper Austria. European Urban and Regional Studies, 20(2), 188–205.

Wenger, E. (1998). Communities of practice: learning, meaning, and identity. Cambridge: Cambridge University Press.

Zaytseva, A., Shuvalova, O., & Meissner, D. User innovation - empirical evidence from Russia (2013). Higher School of Economics Research Paper No. WP BRP 08/STI/2013. Available at SSRN: https://ssrn.com/abstract=2246685 or 10.2139/ssrn.2246685.

Zemtsov, S., Barinova, V., Pankratov, A., & Kutsenko, E. S. (2016). Potential high-tech clusters in Russian regions: from current policy to new growth areas. Foresight and STI Governance, 10(3), 34–52.