# Emergence of Romanian Life Sciences Clusters in the Context of the New EU Industrial Strategy

**Valentin Cojanu, Adriana Petre, Cristina Porumboiu**[1]

***Abstract**: We place this research in the context of the new EU industrial strategy call for encouragement of "place-based innovation and experimentation" with "a new focus on industrial ecosystems". Public attention is redirected again to the basic coordinates of modern competition – value chains and location – although the strategic agenda is compounded by "different risks and needs" of an industry. We illustrate the challenge in the context of a confluence of emergent processes on three levels – industry, cluster, and country, along two dimensions of competitive upgrading – institutional and technological. Against this background, the investigation surveys the climate of cluster development of life sciences in Romania.*

***Keywords:** emergence; cluster life cycle; competitive advantage; technology; social capital.*

## Introduction

The European Union (EU) has been in a constant search for a common vision on economic growth at least since the decision to introduce a regional policy was taken in 1973, and the main financial instrument - the European Regional Development Fund - was created in 1975. By the end of the 1990s, the growth blueprint had gained new momentum with an array of economic initiatives, among which the *Lisbon Agenda* (in 2000), succeeded by *Europe 2020* (in 2010), which shifted emphasis from regional disparities to competitive upgrading (see Ketels and Porter, 2020). As a result, the European Commission began publishing a European Competitiveness Report, issued annually between 1998 and 2014, and follow-up similar studies gradually covered an increasingly diverse scope and top-down approaches to competitive development. *The New Industrial Strategy for Europe*, a vision issued in 2020 whose ambition is to be "entrepreneurial in spirit and in action...with a new focus on industrial ecosystems" (EC, 2020, p. 2), is the last of such endeavours that envisage a competitive repositioning of the EU as leader of global economy.

The strategy answers the needs of an ever-complex economic context, in which "all the value chains" of the industrial sector are part of an agenda that also includes climate neutrality and digital skills as key drivers. The new focus on "industrial

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ecosystems" is rephrasing established European initiatives embracing clusters' "favourable eco-system" and "cluster-based economic strategy" (DG Internal Market)[2] that have entered for long the mainstream of economic policymaking at both national and regional level in the EU. The present thrust is meant to allow "regions to develop and test new solutions with SMEs and consumers, drawing on their local characteristics, strengths and specialisms." (EC, 2020, p. 10)

The recurrent emphasis on cluster advantages is strongly supported by studies (e.g., Menzel and Fornahl, 2007; Delgado et al., 2016) that underscore the performance of clustered versus non-clustered companies by spawning business initiatives to take advantage of the local resources for specialization. The finding is even more endorsed in the presence of R&D-intensive clusters in specific technological fields that correlate most strongly with higher levels of regional productivity growth (Kosfeld and Mitze, 2020). However, despite its venerable tradition that dates to Marshall's seminal analysis (1890), this scholarship has yet to confront periodic challenges, such as the resurgence of global productive networks at the start of the 2000s and, more recently, the emergence of new industrial sectors that redefine the meaning of specialization and of clusters themselves.

Emerging industries come into existence with the creation of a new industrial value chain, or the radical reconfiguration of an existing one, driven by a disruptive idea or ideas, leading to new products/services with higher added value. One of their important components is the life sciences sector due to its potential to become "the largest industry in the world" (Enriquez and Goldenberg, 2000). Life sciences consist of a relatively broad range of disciplines, encompassing "biology, biotechnology, genomics, proteomics, bioinformatics, pharmaceutical and biomedical research and techniques" (World Health Organization, 2005). The life sciences industry includes two traditional sectors – healthcare and pharmaceuticals, plus the newly emerged sectors such as biotechnology, medical devices, and biopharmaceuticals. The productivity of companies grouped in performing clusters is in general 25% above the industry's average productivity effect; in particular, for biotechnology it increased by 50% - 175%, depending on cluster's strength (Hollanders and Merkelbach, 2020).

The promise of superior economic and social benefits has been readily seized by the EU to "be applied for a wide range of purposes for private and public benefits" (European Commission, 2002 (27), p. 10). Endowed with R&D spending of ca. USD 204 bn in 2018 (EvaluatePharma, 2018), the life sciences companies are challenged to anticipate and find solutions for increasing the standard of living and diminishing the effects of healthcare problems. The challenges of an emerging agglomeration combined with the challenges of a traditional industry continuously adapting to new technologies can have different solutions depending on local developments.

We take up this task to explore the conditions of cluster development in Romania, just recently (2020) included in the World Bank high-income country bracket (The World Bank, 2020). Concomitantly, FTSE Russell has announced the change of Romania's Bucharest Stock Exchange (BVB) status from Frontier to Emerging Market in recognition of increased market capitalization and a higher quality of the institutional setting. The life sciences sector exhibits similarly improved performance.

[2] DG Internal Market, Industry, Entrepreneurship and SMEs „Emerging industries and value chains", Emerging industries and value chains | Internal Market, Industry, Entrepreneurship and SMEs (europa.eu) (accessed on 27.01.2021).

Healthcare-associated activities have produced "some of the highest added value outcomes in recent years" (Pîrvu et al., 2020, p. 12) and have been instrumental in providing rapid solutions to the immediate challenges of the medical sector during this epidemic crisis (Clustero, 2020). In the following, we attempt to reveal the context of cluster development in life sciences by shedding light on its premises alongside two dimensions, technological and institutional. The objective is to evaluate, given several constraints of the investigation, the conditions of competitive upgrading against the background of the EU's new industrial strategy to encourage "place-based innovation and experimentation" with "a new focus on industrial ecosystems".

This study contributes to the current literature with a multifaceted cluster analysis in outlining the example of life sciences in the context of a triple emergence – at industry, cluster, and country level. Against this background, we first review the limits, as well as the promises of industrial emergence for competitive upgrading as they reveal themselves in the process of knowledge exchange and setting institutional boundaries between cluster members. Within this approach, we attempt to delineate this strategic challenge in the specific case of life sciences, a sector that exhibits a recognized potential of technological development and business dynamics. Questioning the general lessons in the Romanian context proved a difficult task, mainly due to a relative lack of cluster-based evidence. We have nevertheless taken up this research question because it can reveal the practicalities of the EU industrial strategy from a bottom-up perspective. We conclude by placing our inquiry within the wider concern of withstanding the pandemic economic shock.

**The issue of emergence: competitive challenges at industry, cluster, and country level**

Clusters, succinctly defined as agglomerations of companies and supporting institutions in related industries, exhibit similarities of their life cycle with industries as they form, evolve, or decline (Bresnahan et al. 2001; Andersson et al., 2004; Belussi and Caldari, 2008; Ketels and Memedovic, 2008). Beyond this rather conceptual than empirical finding, evidence sheds light on a remarkably diverse reality, more difficult to put into patterns.

This is especially the case of emerging industries that cut across a wide range of sectoral specializations (Phall et al., 2011) and therefore are prone to hybrid developmental stages when transformative factors of the initial phases – e.g., high uncertainty and risk, untested innovation – coexist with those specific of later stages – presence of specialized suppliers, sophisticated demand, etc. An emerging industry may start with a re-formation of an existing industry or the creation of a new one, but in both cases the change is driven by "technological innovations, shifts in relative cost relationships, the emergence of new consumer needs, or other economic and sociological changes that elevate a new product or service to the level of a potentially viable business opportunity" (Porter, 1980, p. 215).

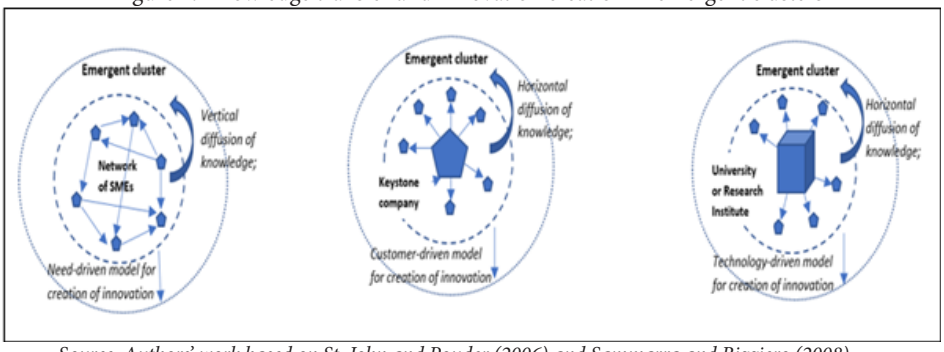
In this view, a generic mix of technology and institutions seems to influence the strategic setting in an emergent context (Taübe et al., 2019; Kosfeld and Mitze, 2020; Tsvetkova et al., 2020), although the depth and breadth of their impact on competitive upgrading in clusters is less researched. This is especially the case of knowledge-intensive sectors that are mostly geographically bounded within regions, while at the same time knowledge is produced and shared worldwide (Miguelez et al., 2019; Graf

and Broekel, 2020). As far as this paper is concerned, there is little known about how the configurations of knowledge networks engender cluster transition, and how these dynamics can be captured and integrated into policies (Abbasiharofteh, 2020; Grashof, 2020). We summarize next two lessons about the impact of this setting on an emergent cluster's life cycle.

First, we expect that clusters in emerging industries perform at a superior level of technological development although not necessarily at a highly competitive level. Emerging industries feature initial conditions that usually are a distinctive mark of advanced stages of cluster formation, such us qualified human capital and strong links between actors (European Commission, 2008), strong locational advantages (Menzel and Fornahl, 2009), or the existence of a robust scientific base (Zucker et al., 1998). A case in point is "Innovation offensive", a cluster in biotechnology, telemedia, and health in Baden-Wurttemberg (Germany), active since 1992 (DTI&ECOTEC, 2004, pp. 13-14). This example illustrates how favourable incipient industry characteristics, technological – e.g., high degree of vertical linkages along the value chain, flexible, high-quality production, institutional – e.g., a political culture of pragmatism and consensus, and locational – e.g., high levels of regional sourcing, strong supplier linkages, translated gradually, with public support as well, into competitive performance. In other instances, as the example of biotechnology companies in Lombardy (Italy) (Orsenigo, 2001) or regional innovation networks in French clusters during 2005-2010 (N'ghauran and Autant-Bernard, 2020) show, linkages among cluster members prove ineffectual in terms of sustaining competitive advantages, despite solid technological premises.

The initial conditions of cluster formation point to either an industry or a technological identity of the agglomeration (St. John and Pouder, 2006; Tsvetkova et al., 2020). If the agglomeration has an industry identity, say financial services, clusters emerge under factors such as external economies of scale, network economies or social capital, which are prevalently manifest in economic agglomerations and are supposed to endow cluster members with superior competitive advantages as compared to non-clustered companies in the same industry (Marshall, 1890; Porter, 1998; Menzel and Fornahl, 2009; Delgado et al., 2016). If it has a technological identity, such as emerging industries, cluster members are expected to facilitate the knowledge exchange horizontally, channelled through research-intensive specializations, rather than vertically as knowledge is exchanged between actors as they start to collaborate within the cluster (see Figure 1).

Figure 1. Knowledge transfer and innovation creation in emergent clusters




*Source: Authors' work based on St. John and Pouder (2006) and Sammarra and Biggiero (2008).*

Technological knowledge is defined by Sammarra and Biggiero (2008, p. 805) as the "know-how and competences necessary to the process and execution of product and process development and includes scientific knowledge as well as applied and experimental knowledge". Accordingly, a model of knowledge exchange may take the form of (a) a technology-driven model, where technological knowledge is developed by research and development activities, or (b) a customer or need-driven model, where market knowledge is exploited via customer interactions and market signals. A corollary of this observation is that conditions of competitive performance are correspondingly more favourable although not necessarily certain for the emerging industries than for traditional ones.

"The institutional context differs between clusters and their countries" (Konstantynova and Lehmann, 2017, p.1) is a conclusion that may sound trivial, but it helps to explain why variations are more likely to occur when emerging industries are considered, which brings us to the second lesson: further stages of competitive upgrading at cluster level require advanced stages at both country and industry level, of development and life cycle, respectively. Further upgrading depends indeed heavily on specific technologies to which actors remain tied up due to the operation models they follow (Ketels and Memedovic, 2008), but the length of the sustaining phase or cluster resilience also requires a certain robustness of the general business environment (Martin and Sunley, 2006; Delgado et al., 2016).

The role of institutions in understanding growth, economic performance, and providing for the conditions that enhance learning and innovation is well established in the literature. What makes them however specific in the context of cluster development may consist of the so-called "social technologies" (Nelson and Sampat, 2001), a concept that originates in the idea that institutions matter because they create the opportunity of interconnectedness between actors. An example is "learning-by-monitoring" (LBM), a finding of Perez-Aleman's work (2005) on the emergence of dynamic clusters in Chile. The institution-building process enables coordinated LBM among cluster members to improve capabilities, processes, and products. The emergence of institutions in new clusters makes possible LBM as a key explanation of cluster growth. Economic actors create institutions that enable LBM "by jointly setting goals, standards and ways to evaluate progress and capacities to reach those targets" (Perez-Aleman, 2005, p. 653). As the cooperation and trust between actors intensifies, the cluster organizations are motivated to arrange network activities, to facilitate the cluster's innovation and to continuously promote the cluster for attracting investments and human capital (Burger et al., 2015).

**The challenge of emergence: working hypotheses and methodology design**

Companies, regardless of their membership to a cluster, need an infusion of capital to accelerate product development and in effect, to protect their innovative solutions through patents. This financial demand is a continuous constraint for their development (Carrick, 2016), firstly for research and development activities, and then for marketing, distribution, and commercialization of products. The more so, as a finding of Carden et al. (2010) states, the availability of capital to life sciences companies, especially for research and development, has direct effects on their innovative approach. The technological dimension of clusters in emerging industries reflects an organizational advantage in the form of innovation support for companies –

via access to both technological knowledge and financing.

Financial support can be provided by public authorities, traditional investors such as banks, or alternative investors such as venture capital or private equity funds. While the grants cannot cover a large demand of funding or banks require collateral to guarantee the loans, the private equity funds can inflow capital in accordance with company's development and offer expertise for its evolution. A series of studies (Kortum and Lerner, 2000; Hellman and Puri, 2000; Engel and Keilbach, 2007; Caselli, Gatti and Perrini, 2009), conducted in different countries and for different sectors, confirms that investments received by companies from private equity investors helped them with the research and development activities. The quantitative estimate of the impact is self-evident: "a dollar of venture capital appears to be about three times more potent in stimulating patenting than a dollar of traditional corporate R&D" (Kortum and Lerner, 2000, p. 675).

The current literature does not yet include evidence of increasing attractiveness of investors for clustered companies compared with non-clustered; however, a visible and competitive cluster can become more attractive for investors, and cluster organization promotion efforts are especially vital for financing high-risk operations of life sciences companies (Burger et al., 2015). Thus, we lay out our first working hypothesis on the premise that *clusters' life sciences companies display a higher degree of innovative products and processes than similar companies outside clusters due to access to both in-built and acquired advantages as to the exchange of technological knowledge and access to finance*.

On the other hand, life science clusters are better positioned to upgrade the institutional milieu, especially regarding social capital formation among other components. Social capital, in both formal (e.g., norms, laws, rules, regulations, policies) and informal (e.g., values, customs, morals, trust) representations, is relevant to cluster building along its entire life cycle. In contrast to natural, technological, or economic capital, social capital is "the most diversified, least homogenous form of capital." (Westlund and Bolton, 2003, p. 88)

According to Zhang (2014, p. 3), social capital is perceived through its emergent and context-based nature, which it is believed "to originate from dynamic guanxi[3] (with physical, institutional and mental/psychological elements) rather than static network". Drawing on cases of top-down and bottom-up organized clusters in China, Zhang (2014) concludes that social capital is dependent on a facilitative platform both (1) context-sensitive by providing multiple links between problems and resources, and (2) efficiency-enhancing based on human agency and situational factors. This finding corroborates with Stephens and Sandberg's (2019, p. 2), which explains the practice of clustering as "a recurring set of coordinated and future-oriented activities through which regional actors collectively attempt to restructure the regional context to support cluster emergence better". We premise then that *a life sciences cluster exhibits a greater potential process than similar companies outside clusters for enhancing social capital and thus the institutional dimension of an emergent cluster*.

However, our previous discussion should make us aware of a lesser prevalence of the above hypotheses in business environments that are less advanced. As we recall, the findings suggest that the specific practice of clustering that takes root in each region helps explain why some nascent agglomerations develop into a functioning and viable

[3] Guanxi is the meaning of "social network" in Chinese language.

cluster, while others do not. We thus expect that our premises be qualified by the context of the Romanian economy and should only point with some reservations to generalizable conclusions.

**Research design**

We collected data from publicly available records and a survey. The survey[4] was sent to the representatives of two selected clusters – RoHealth and ImagoMol – that are illustrative for the life sciences sector in Romania (see Table 1), both in terms of organizational performance, as measured by the ESCA score[5], and membership. We based our approach on the respondent's experience and knowledge of the development and management stage of the cluster, which make her/him belong to one of the main categories of cluster members: large enterprises (with more than 250 employees or a turnover of more than 50 million euros), small and medium-sized enterprises, universities and research institutes, professional associations, national and local authorities, suppliers, support services and catalyst organizations. The estimated time to answer the questionnaire was about 40 minutes to cover questions in four parts: A. Basic information about the cluster representative, B. Chronology of cluster development, C. Institutional context, D. Technological context. The questionnaire did not contain personally identifiable data and could be completed during the application period from 20 to 31 July 2020 and its extension from 14 Sep. to 9 Oct. 2020. To adapt the survey to circumstances, as well as to consider the relatively limited practice of cluster surveying in Romania, we followed Rowley (2014) and designed questions so that they should be as short as possible, not be leading or making implicit assumptions, not be vague or general, not invite respondents to breach confidentiality.

**Table 1. Romanian life sciences clusters**

| **Cluster name, date of establishment, ESCA label[a)]** | **Location** | **Members[b)]** |
|---|---|---|
| ROHEALTH - Health Cluster Romania (28 May 2015)<br>Silver (2019-2021) | Bucharest | 73 |
| North-East Regional Innovative Cluster for Structural and Molecular Imaging (IMAGO-MOL) 7 September 2012<br>Silver (2019-2021) | Iași | 44 |
| Asociația LifeTech City<br>20 May 2012 | Târgu Mureș | 29 |
| bioROne 1 March 2012<br>Bronze (2016-2018) | Iași | 20 |
| ROVEST Cluster 4 July 2016 | Timișoara | 21 |
| Health Romania The Medical Cluster 15 April 2014<br>Bronze (2016-2018) | Bucharest | 20 |

*Source: Authors, based on www.clustercollaboration.eu/cluster-organisation and clusters official websites.*

[4] Available at Chestionar destinat evaluării provocărilor dezvoltării clusterelor în științele vieții (20 - 31 July 2020) [Survey dedicated to evaluating the challenges of cluster development in the life sciences industry].

[5] According to the following criteria: 1) structure of the cluster, 2) strategy and governance of the cluster initiative, 3) financing of the cluster management, 4) range of services and activities provided by the cluster management organization, 5) involvement and interaction with the cluster actors, and 6) achievements and recognition of the cluster organization. See note a) in **Table 1**.

a) The European Commission introduced the European Cluster Excellence Initiative (ECEI) in 2009. This is an evaluation based on 36 indicators grouped in six classes. Based on these indicators, the European Secretariat for Cluster Analysis (ESCA) has introduced a three-level label system ranging from good to excellent cluster management, or bronze, silver, and gold (see https://www.cluster-analysis.org).
b) Cluster membership as valid on Oct. 2020.

The current pandemic prevented us from organizing fact-finding visits on the cluster sites. Therefore, we mostly attempted to reach out online to respondents who qualified at best for our criterion of being representative and knowledgeable about their cluster economics and eventually fetched up a total number of thirteen answers. Respondents were representatives of educational organizations (23.1%), SMEs (23.1%), research institutes, associations, non-governmental organizations (15.4%), and regional hospitals (7.7%). Although the surveyed participants have a broad view of the cluster's situation, their limited number and the lack of representation of companies could be considered a limitation of this study.

## Romanian life sciences clusters: a discussion on their institutional and technological impact on competitive upgrading

*The context of cluster emergence*

Notable cluster-like developments have been registered both before and after Romania's accession to the EU in 2007 (Cojanu et al., 2003; Cojanu and Pîslaru, 2011), but they have remained virtually outside the realm of public interest in contrast to the formal, non-governmental, non-profit organization, policy-driven initiatives of cluster formation that emerged mostly under the guidance of the EU policy (InovCluster Study, 2008-2010). By April 2020, there were 76 cluster organizations registered, out of which 47 were members of the Romanian Cluster Association – CLUSTERO[1] and three clusters had been awarded the Gold Label, the best performance in Eastern Europe for cluster management (Ministry of Economy[2]).

The clusters we selected for this study were part of this top-down strategy for cluster development, being established quite recently, ImagoMol in 2012 and RoHealth in 2015. They are part of the broader sectors of "health" - wellness, pharma, and cosmetics – with three clusters in the Centre and North-East regions, and "biotechnologies" with three clusters in the North-East, South-East, and South regions) (Pirvu et al., 2020).

RoHealth is the largest cluster by membership of life sciences industry in Romania. It has a network of 18 universities or research institutions, including the most prestigious Romanian university of medicine and pharmacy "UMF Carol Davila", 39 SMEs and several hospitals. ImagoMol (North-East Regional Innovative Cluster for Structural and Molecular Imaging) is a medical imaging cluster founded within the framework of an EU-funded project, whose title is illustrative for the public support in cluster formation – "Advanced Medical Imaging on the project, interdisciplinary and integrated by creating a network of Regional Clusters and Development Strategies in Europe" (AMI-4Europe). While Ro-Health primarily clusters around the country's capital, ImagoMol's location in the North-East, where a large, domestic, privately-owned pharmaceutical company is also present, is no less advantageous, having as members key national and local players such as the University of Medicine and Pharmacy "Gr.

T. Popa" Iași, Romsoft, or the Regional Oncology Institute, next to members from academia and healthcare, as well as SMEs and public bodies.

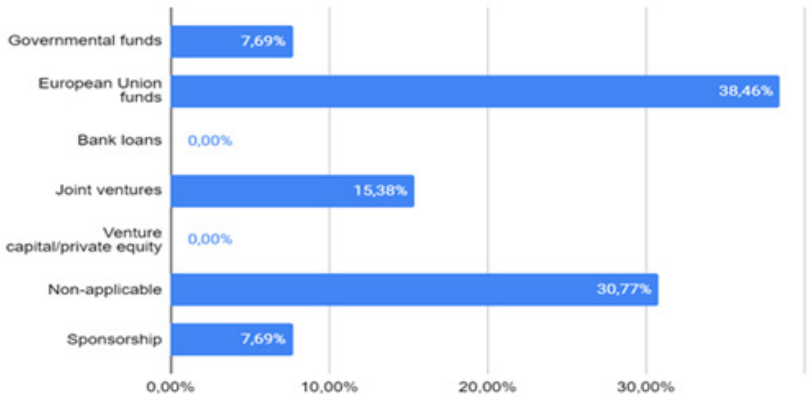
Probably one of the most forceful conclusions of this study is to find that the largest part of respondents considers both clusters already in the maturity phase, despite the manifest absence of many ingredients specific to an entrepreneurial phase, as became evident during the survey. There is a general acknowledgment of the virtually inexistent prior networking between the members, while most of the present efforts are still taken over by administrative tasks such as day-to-day management, brokerage, meetings, certification, with a tendency though to increasingly prioritize research partnerships.

*The technological context*

Cluster companies perceive the opportunity to foster in-house innovation via four main activities: knowledge transfer within the cluster; promotion of innovation; partnerships with academia, and partnerships with large corporations. Most respondents confirm the cluster advantage of easy access to high technology know-how, alongside with access to updated news (92% of answers) and to seed capital and/or private equity (60%). Knowledge exchange is mainly carried out as (a) technological knowledge, involving universities or companies; (b) managerial knowledge, either via cluster management or cluster newsletter; and (c) market knowledge. In general, the answers indicate willingness to pursue the perceived benefits rather within than outside the cluster.

However, none of the benefits of being a cluster member, for both RoHealth and ImagoMol, does not yet include probably the greatest challenge for enhancing innovation – strengthening financial capabilities. The largest part of funds is sourced externally, from the European Union, and through joint ventures (see Figure 2). The large share of players for whom that challenge is a non-issue (30.77%) is also indicative of an early stage of developing business let alone competitive advantages.

**Figure 2. Financing sources for the members of RoHealth and ImagoMol**




*Source: Authors' data.*

Despite the members appreciating access to private capital being part of the cluster (60%), this financing possibility is not considered for the surveyed entities. However, 77% of the respondents consider that the companies of the clusters are attractive for venture capital investors (medium to great attractiveness). With capital expenditure for research and development activities less than 25% of the annual budget of their own R&D departments, 38.4% of the respondents are highly likely to pitch venture capital investors for financing their activity, plus managerial support. Thus, venture capital investors can have a positive impact over the internal innovation of clustered companies, although only as an opportunity in the long run.

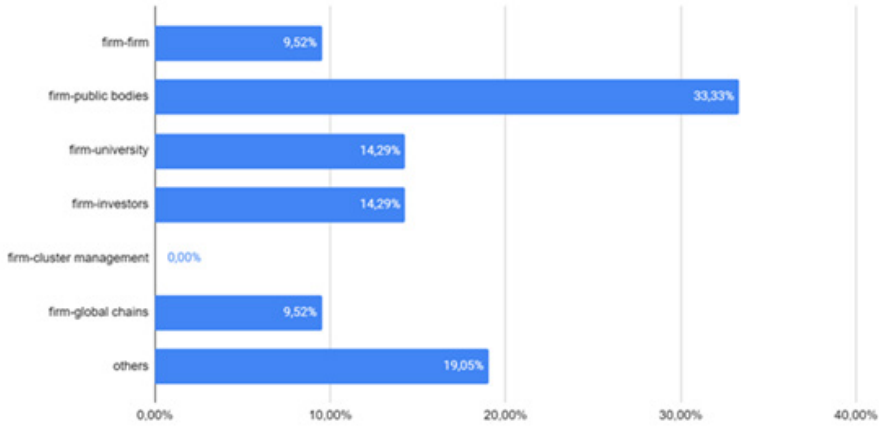
*The institutional context*

Local resources are highly interconnected, making territorial capital unique in each place and not easily imitable, a literature insight which seems warranted by our case: trust as an element of social capital (evaluated qualitatively through cluster collaboration) is the relevant ingredient for the way members build strategies and maintain business relationships in proportion of 76.9%. Cultural values, another element of social capital, count less than trust, and are equal with norms (69.2%). At the same time, for each cluster, the Triple Helix structure (the relationship between academia, public bodies, and companies) is relevant and a clear indicator of cluster collaboration. A large part of the respondents agreed that the collaboration with local or central authorities is key for cluster members.

Three answers are worth mentioning to demonstrate that not only formal rules are valued among members' collaboration, but also synergic connections. One member of Imago-Mol mentions collaboration based on a top-down approach, intermediated by the cluster management and periodical work meetings, but also on synergic connections. Another member of RoHealth observes how formal rules count more than synergic connections, as members enter the cluster via recommendation of another existing member, or a bottom-up approach. For another member of the same cluster, the synergic connection through participation in a common project is considered a common organizational practice. Although opinions differ from member to member, the conclusion is that both synergic connections and formal rules are embraced in both clusters.

Another argument which sustains the emergence stage of the clusters consists of the inter-institutional barriers that tend to form between firm and university, firm and investors, and firm and public organisations in the highest scores (see Figure 3).

**Figure 3. Inter-institutional barriers in cluster emergence**




*Source: Authors' data.*

To lower the inter-institutional barriers, the survey participants thought of solutions such as "communication, tolerance and openness towards new things", "training of the staff", "patience", "communication and collaboration" or "an effective marketing research strategy", which all are important due to both their diversity and as a premise to consolidate the emergence phase. At the same time, competitive networking and partnerships of the type "firm-firm" and "firm-value chain" are not a generalized practice and few indications point to that end in the near future unless a vigorous approach to competitive upgrading is embraced.

Clusters' participants were asked to mention up to three advantages and disadvantages of collaboration between cluster members. The most frequent answers for "advantages" were social implication, trust, common interests in technology development, market visibility, joint publishing, or know-how transfer; as "disadvantages", they mentioned co-dependency, compromise, or difficult collaboration with more qualified staff.

Overall, the answers reflect a relatively advanced stage in putting the basic building blocks of institutional and technological development, which may be a consequence of the advanced industrial specialization. The confluence of a triple emergence, as the case of life sciences in Romania suggests, points to a general absence of competitive linkages at cluster level, of notable market entries at industry level, and of place-based, specific support at country level, which all have the potential to delay considerably the process of competitive upgrading.

**Conclusions and future research directions**

This paper explores the life sciences conditions to evolve as "industrial ecosystems" in Romania, considering the recent EU strategic focus. Our case supports the view that the main feature of the life sciences industry as a mix between understanding, translating, and transforming acquired knowledge into innovation stands for a good premise of cluster development. By virtue of natural and acquired advantages, it may feed a broader view of competitive development, one that includes policy approaches addressing changes across technologies, infrastructures, regulatory frameworks, and societal dimensions.

The case study brought evidence about the key elements which enhance the innovative power of the life sciences companies: collaborative environment within an institutionalized structure, formed and organized based on their needs, and access to multiple types of knowledge or finance. Expectedly or not, our remarks do not differentiate towards some advantages or disadvantages the Romanian clusters may have exclusively due to national business environment. However, in terms of enhancing innovation via investments in research and development activities, our findings bring into attention a weak side of the clustered companies: the largest part of innovation is publicly financed via different development funds of the European Union, compared with clustered companies of more developed countries, such as Western or Nordic countries, where private capital is pivotal in sustaining competitive advantages.

Further research may address a different perspective about the indispensable public funding to support life sciences companies in upgrading competitive advantage. The current COVID-19 pandemic has pressured the healthcare system to rapidly respond to disease controls and sanitary malfunction. European Commission's position regarding research and innovation has been reinforced during the current crisis as the main tool for a fast recovery and implementation of the environmental and digital shifts set out in the recently adopted *New Industrial Strategy* (March 2020)[3]. Thus, the emerging medical device industry is strongly encouraged to bring technological solutions; the e-health sector is experiencing the best conditions to boom, while pharmaceutical companies are directly "asked" for affordable medicines and solutions to meet unprecedented medical needs, via the new pharmaceutical strategy for Europe (EU, 2020)[4].

As industry accounts for more than 20% of the EU economy, employing about 35 million people, and small and medium-sized enterprises are the backbone of the EU economy, the revised version of the *New Industrial Strategy* should focus more on empowering these types of enterprises. SMEs are also fundamental for life sciences clusters, many of the clusters being industry-driven. Therefore, we would not make an understatement when asserting that boosting SMEs would actually empower the European life sciences industry.

In the wake of both the European Commission's and the European Parliament's vigilance into monitoring the "transformation of European industry and its resilience in the aftermath of the pandemic" (Euractiv, 2021[5]), the future agenda of the Romanian life sciences clusters should include decisions about strengthening competitive linkages among members, the more so they are natural representatives of research, market trends, and regulatory bodies. They should think in global terms, by embracing the advantages of also being part of value chains and build successful strategies to continuously prepare for entering new markets and taking up new challenges. Thus, these efforts would cause the clustered firms to advance towards superior life-cycle stages and to consolidate their levels of social capital.

**Endnotes**

[1] The Clustero website is available here: http://clustero.eu/.

[2] More details are available here: http://economie.gov.ro/aparat-propriu/economie/politici-industriale.

[3] European Commission, European industrial strategy, https://ec.europa.eu/info/strategy/priorities-2019-2024/europe-fit-digital-age/european-

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