In Pursuit of Cluster Organizations: A Growth Strategy for Regional Economies

Identifying Regional Determinants of European Cluster Organizations

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Abstract

The strategic and economic importance of the role of cluster organizations is growing. Clusters are considered a key factor for sustainable economic growth as they raise the competitive advantages and innovative strengths of regional economies and firms (Ketels et al., 2012; Sölvell and Williams, 2013). Although cluster policies vary considerably across regions and countries, most cluster programs within the European Union pay dedicated attention to the funding of cluster organizations (Lämmer-Gamp et al., 2012). Despite limited knowledge concerning the function and heterogeneous nature of cluster organizations (Lindqvist, 2009; Ebbekink and Lagendijk, 2013) they are a crucial factor in regional policy-making and long-term economic development (Porter, 2000; Ketels et al., 2012).

The main objective of this study is to identify determinants justifying the regional variation in the number of cluster organizations hosted in life sciences sectors across 15 EU-member states. Employing cluster organization data at a NUTS-2 regional level and the European Cluster Observatory's Regional Ecosystem Scoreboard a conceptual model was built with assumptions based on the national systems of innovation approach. Evidence is found that the quality of the knowledge basis and skills within a region is positively related to the number of cluster organizations the region hosts, whilst the level of the demand is negatively related. Also, results from the robustness test provide evidence that a mix of entrepreneurial attitudes, activities and aspirations and the relationship of these factors and economic development is not as straight forward as thought. Further research should focus on making findings from this research more generalizable.

Chapter 1: Introduction

Clusters are a striking and highly typical feature of virtually every national, regional, state, and even metropolitan economy (Porter, 1998b). For the last two decades the economic relevance of agglomerations and their impact on economic performance has been subject to economic research, creating insights into how firms continuously create competitive advantage. Michael E. Porter's contributions to this field were the start of what is now known as 'cluster' research. Porter identified the advantages of clustering, in the context of the performance of a nation's economy and the state of innovation, as a creative and interactive process involving market and non-market institutions (OECD, 1999) and competitiveness of actors involved (Porter, 1990; 1997a; 1998b; 1998c; 2000; 2003).

Regional economic ecosystems of inter-industry interdependencies (Delgado et al., 2014), clusters, enables the spill-over of knowledge and facilitation of co-operation as well as competition. According to Porter (1998b) clusters affect competition in three broad ways. First, being part of a cluster allows firms to operate more productively. Clusters also drive the direction and pace of innovation, which underpins future productivity growth. Finally, clusters stimulate the formation of new businesses, which expand and strengthen the cluster itself. Clusters play a significant role in raising the competitive advantages and innovative strengths of regional economies and firms (Ketels et al., 2012; Sölvell and Williams, 2013), and are thus considered key factors for sustainable economic growth. According to the most recent European Cluster Observatory (ECO) data, 39 % of jobs and 55 % of wages, in Europe can be accounted for by economic activities located in clusters (Bieńkowska and Creţu, 2016). Although the benefits of clusters are relatively straightforward, several authors remain sceptical about the effectiveness of clusters (Maskell, 2001; Martin & Sunley, 2003; Kukalis, 2010).

A cluster of independent and informally linked companies and institutions represents a robust organizational form that offers advantages in efficiency, effectiveness, and flexibility (Porter, 1998c). Cluster organizations are geographically concentrated, dynamically interacting combinations of firms, intermediaries, funding organizations and transfer agencies (Cooke, 2001) that facilitate strategic co-operation across clusters, within cluster operations and between cluster actors (organizations, firms and universities) within the cluster (European Commission, 2008). Although cluster policies vary considerably across regions and countries, most cluster programs within the European Union pay dedicated attention to funding cluster organizations (Lämmer-Gamp et al., 2012). Moreover, cluster organizations are an important driver of competitive advantage of clusters (Ketels et al., 2012; Lindqvist, 2009; Sölvell and

Williams, 2013), particularly in knowledge intensive industries (Baptista and Swann, 1998; Bell, 2005; Huber 2012).

It is evident that governments play an integrating role in managing knowledge on an economy-wide basis by making technology and innovation policy an integral part of overall economic policy (OECD, 1999). As the number of development programs that support the establishment of cluster organizations increases (MacNeill and Steiner, 2010; Sölvell and Williams, 2013) cluster organizations become an increasingly prominent component of, both regional and national level, development policies (Lindqvist and Power, 2002; Teigland and Lindqvist, 2007; Glaser, 2013; Bieńkowska and Creţu, 2016). As cluster organisations become a prevalent component of national and regional economic development (Sölvell, Lindqvist and Ketels, 2003) evaluating the impact of cluster policies and programs becomes indispensable.

Since the early 1990's, research in the area of clusters has shifted focus to become quantitatively oriented. This creates a transparent, data-rich foundation on the basis of which of the economic size and impact of clusters can be evaluated. However, there still lacks a thorough understanding of the function and heterogeneous nature of cluster organizations (Lindqvist, 2009; Ebbekink and Lagendijk, 2013). Despite limited understanding, cluster organizations are a crucial factor in regional policy-making and long-term economic development (Porter, 2000; Ketels et al., 2012). Recent literature has shown there is considerable regional variation in the presence and activities of cluster organizations (Isaksen and Hauge 2002; Ketels et al. (2012). Exploring this variation may provide additional insights into the roles of cluster organizations across regions and industries (Burger et al. 2015). This paper identifies a number of regional dimensions which may justify the variation in the number of cluster organizations across regions in the European Union. My findings could significantly contribute to more goal-oriented policy-making long-term economic development.

By means of combining existing understanding of cluster organizations with the national systems of innovation approach I have constructed a conceptual model. This is the core of my research and builds on five dimensions within which 16 sub-dimensions determine the quality of conditions of regional ecosystems. The 5 dimensions take into account growth and access to finance, knowledge creation and transfer, entrepreneurship culture, activities and capabilities, dynamics of public and private demand and the degree of collaboration between cluster actors. These dimensions incorporate the most important regional determinants which influence the number of cluster organizations hosted in a region. Findings indicate that three of the dimensions are statically significant. They imply that the availability

and development of human capital in a region is positively correlated to the number of cluster organizations. Contrarily the dynamics influence by public and private demand and conditions of entrepreneurship are negatively correlated.

Where many studies have investigated the role clusters and cluster organizations have, little is known about the regional variation in the number of cluster organizations hosted in a region. More notable, literature on the regional determinants of cluster organisations is remarkably scarce. The primary contribution of this study is that this is one of the first studies to explore the regional variation in the number of cluster organisations hosted across economic regions. As identified determinants justify this variation, this research contributes to the generalizable quantitative assessment of the impact cluster organizations on the competitive advantage of clusters (Burger et al. 2015). Furthermore, the conceptual model based on the national systems of innovation approach is the first of its kind. This is the first attempt to combine the national systems of innovation approach and theory on cluster, largely inspired by the works of Michael E. Porter.

The remainder of the paper is organized as follows. Section 2 of the paper will outline historical developments of regional innovation systems, cluster organizations and the regional determinants of cluster organizations. Firstly, section 2 discusses the contribution of regional innovation systems and cluster evolution to region's economic growth and its competitive advantage. Part two of the literature review discusses cluster organizations, regional innovation governance & policy and the role of cluster organizations as an intermediary. Finally, cluster organizations will be mapped and relevant regional determinants will be identified. Section 2 also develops the research question and hypotheses after which section 3 describes the model and data used to empirically test these hypotheses. The results of the analysis are presented in Section 4, while the discussions of the findings are presented in Section 5.

Chapter 2: Theoretical Framework

Ever since Schumpeter's contribution on business cycles (1939), the economic literature has been addressing the positive relationship between innovation and economic development (Acs et al., 2016). Additionally, the competitive advantage of regional and national economies is an ever-growing concern for policy-makers (Ketels, 2006). National and regional systems of innovation are now seen as a way to boost economies (Lawlor, 2014). This is why the geographical concentration and co-ordination of economic activities, across interconnected firms and institutions, the concept of clustering, is widely considered an effective tool in stimulating regional economic development, across the world and for a wide variety of industries (Cooke, 2001; Cumbers and MacKinnon, 2004; Lindqvist, 2009; Porter, 1990; Sölvell, 2008). The characterization of local concentrations of specialized activities (Marshall, 1890) has, over the past century, developed into defining the advantages of swarming, or the clustering, of such economic activities once concentrated in and around agglomerations (Schumpeter 1939). Becattini (1979) further developed the concept, introducing the importance of place-based economics, after introducing the industrial district phenomenon for regional policy and territorial development purposes.

Anno 2016, the long observed, still relevant, economic phenomenon is still a topic of debate. Productivity, innovation and new business formation are enhanced as an economic community based on informal and formal, hard and soft forms of networking between firms and agencies (Cooke, 2001). Specialization leads to the sticky location advantages that are the true sources of a firm's sustainable competitive advantage which can be extended to that of regions and countries (Porter, 1990; 1997a; 1998b; 1998c; 2000; Smit, 2010). However, various schools of thought stress a different factor that influence economic growth and so the complex heterogeneous nature clusters of remains debateable.

The following chapter will provide insight into the relevance of clusters and cluster organizations in national systems of innovation, their impact on economic development and competitiveness, cluster organizations as part of regional innovation policy, their role as an intermediary and the economic complexity of mapping cluster organizations. This will be the basis of a framework I will use as a tool to analyse the variance in the number of cluster organizations across regions in Europe. It should be noted that a detailed discussion on cluster organisations will follow the discussion on clusters and the national systems of innovation approach.

2.1 Clusters

Ever since *The competitive advantage of nations* (Porter, 1990) innovation policy has been highly concerned with clusters and cluster development. Regardless of the attention, there is no consensus on the definition or a fits-best approach towards clusters (Verbeek, 1999). Jacobs and De Man (1996) did however distinguish three groups of cluster notions; regionally concentrated industry, sectors or groups of sectors, and production chains. Clusters do remain ambiguous but for the sake of discussion I define clusters based on the first notion; geographical concentrations of specialised firms, advanced skills, and competences (Bieńkowska and Creţu, 2016). Clusters consist of companies, government agencies, academia, and research and financial institutions (Sölvell, Lindqvist and Ketels, 2003) that cannot be categorized into the narrow sectoral views (Raines, 2002). A cluster's boundaries are defined by the linkages and complementarities across industries and institutions that are most important to competition (Porter 1998b), which can be traced to historical circumstances.

Cluster Growth and Economic Development

The similarity-based regional cluster approach stems back to Marshall's *Principles of Economics* (1890). According to Marshall the main advantage of spatial proximity and localized industries is that it stimulates interaction. This interaction between cluster actors as localized industries has similar needs with regards to framework conditions (Verbeek, 1999). Close spatial proximity makes information more transferrable and offers the advantages of a common language, mutual understanding, easy observation and immediate comparison (Malmberg and Maskell, 2002; Gertler 2003; Storper and Venables, 2004). The increased knowledge flows foster the exchange of tacit knowledge, encourages collaboration in research and learnings amongst the cluster actors which seems to have the most impact in knowledge intensive industries (Bathelt et al., 2004; Dahl and Pederson, 2004; Martin and Sunley, 2003; Waxell and Malmberg, 2007).

The benefits of clusters in enhancing regional economic development are evident (Burger et al., 2014), but what drives the formation and development of clusters? Porter's work on clustering in the 1990's (Porter, 1990; 1997a; 1998b; 1998c; 2000) provides us with valuable insight into the benefits of and factors leading to the formation and development of clusters. Clusters can be traced to historical circumstances where they arise from unusual, sophisticated, or stringent local demand (Porter, 1990). One example is the Dutch transportation cluster which owes much to the centralized location of the Kingdom of the Netherlands within Europe, the extensive network of waterways, the historical Port of Rotterdam's scale and efficiency, and the skills accumulated by the Dutch over a long lasting maritime

history. Modern clusters often arise from collaboration between innovative firms that stimulate the growth of many parties and in turn, foster cluster development.

Cluster development is a 'cooperative long-run process' which involves a wide range of stakeholders. Once seeded a self-reinforcing cycle that stimulates competitiveness strategies of cluster actors and promotes the cluster's growth, especially when local institutions are supportive and local competition is vigorous (Porter, 1998c; Martin and Sunley, 2003). Clusters and cluster actors continuously evolve but could require decades to develop a real competitive advantage or contribute to economic development. As clusters grow their influence over public and private institutions grows, information accumulates, they signal opportunity and attract human capital, entrepreneurial individuals and specialized suppliers and local institutions develop specialized training, research, and infrastructure as the cluster's strength and visibility grow (Porter, 1998c).

Clusters not only contribute to national productivity, often clusters also affect the productivity of actors involved in *other* clusters due to knowledge spill over effect. Moreover, it is not guaranteed that the formation or development of clusters will at all contribute to national production, economic development, competitiveness of actors or innovation. It is important for policy-makers to note that market forces, not government decisions, determine the outcomes (Porter 1998). Policy measures should not be aimed at achieving a set goal and policy makers should not expect that clusters created overnight will result in instant gains in productivity (Lankhuizen and Woolthuis, 2003). Policy-makers aim to facilitate the process of innovation, should focus on strengthening the self-reinforcing cycle and fostering the growth of clusters.

Cluster policies are an important tool to regional economic growth, by unlocking new business opportunities, and creating a competitive advantage, through interregional cooperation (Bieńkowska and Creţu, 2016). The promotion of cluster activities through interactive communication with actors in and outside the cluster community (geographic and social) can stimulate the cross-cluster, -border and -industry knowledge sharing and integration into global markets (Bathelt et al., 2004; Birch, 2008; Moodysson, 2008; Ketels and Memedovic, 2008). In the next section I will explain why cluster development are of interest to policy-makers and how cluster policies are economically relevant, the types of cluster policies and the actors involved.

Cluster Policy

The cluster concept has become a popular guideline for regional policies as they stimulate specialization, collaboration and innovation of firms. These factors contribute to firm level productivity which stimulates the transformation of ideas and opportunities into marketable concepts (March, 1991; Sölvell et al., 2003; Fromhold-Eisebith and Eisebith, 2005; Teigland and Lindqvist, 2007; Lindqvist et al., 2013;). Furthermore, productivity and innovation activities contribute to the competitiveness of nations which depends on the capacity of a nation's industries to innovate and upgrade (Porter, 1990). Hence, an economy with a stimulating innovative atmosphere should be top priority for policy-makers (Spielkamp and Vopel, 1999). This however cannot be extended to the assumption that simply constructing a cluster will attract firms and an innovative atmosphere or lead to economic development.

Cluster aimed policy mixes, rather "a clusters of policies" than "cluster policies" (Nauwelaers and Wintjes 2008), will for the sake of discussion be referred to as "cluster policy". Cluster policies provide policy-makers with a "central toolkit" to engage with and develop sectors of the economy and guide competitiveness and innovation (European Commission, 2013). Common activities that make part of this toolkit include supporting collaborative actions and upgrading the cluster-specific business environment, long-term co-operations considered to be important drivers behind industrial development or cross-industry co-operation in developing new products or services and developing new applications of technology (European Commission, 2013; Izsak et. al., 2015).

Cluster promotion is the outcome of either explicit top-down or implicit bottom-up approaches (Fromhold-Eisebith and Eisebith; 2005). Explicit cluster policies are established, financed and implemented top-down by local, regional or national level public authorities (Kaiser, 2003; Dohse, 2007; Teigland and Lindqvist, 2007; Trippl and Tödtling, 2007; Waxell and Malmberg, 2007) whilst implicit initiatives are organized and financed bottom-up by non-governmental actors, including firms, industry associations, and universities (Caspar and Karamanos, 2003). Once more, for the sake of discussion an example portraying the socio-economic relevance of cluster policy will be given. Smart specialization, an important concept for more targeted innovation policy, one where cluster development greatly contributes to regional economic growth, competitiveness and innovation. Whilst clusters policies provide a conceptual framework to describe and analyse aspects of the modern economy, smart specialization is more a programmatic framework to guide policy (European Commission, 2013). Smart specialization can be very effective due to its systemic and strategic nature but should be seen as one of the many tools policy makers can use to stimulate collaboration and cluster formation in a region.

A region undergoes smart specialization when an entrepreneurial search and discovery process identifies the regions' competitive advantages and related innovation opportunities (Bieńkowska and Creţu, 2016). The role of government agencies is to provide incentives for innovation driving institutions, such as universities and research institutes, to become involved in identifying the regions' specializations (Coffano et al., 2014). Cluster policies and smart specialization strategies, tools which generate growth in the EU, do so by unlocking new business opportunities in new value chains and by creating synergies through interregional cooperation (Bieńkowska and Creţu, 2016).

A large disadvantage of smart specialization is that it requires continuously monitoring which is often time consuming and expensive. It is necessary in order to assess effectiveness and to make sure that incentives are directed to where they can add most value, in terms of creating jobs and growth and supporting industrial transformation (Foray, 2015). Clustering plays an important role in designing smart specialization strategies and in the implementation of these strategies (Bieńkowska and Creţu, 2016). The promotion of networking through clusters has been among the most successful instruments for supporting innovation (Bieńkowska and Creţu, 2016).

Frequent mismatching of the internationalisation efforts within specific industries, cluster efforts and support received from cluster organizations has had its toll. Even though clustering fosters integration into global markets, the strategic importance of global integration is decreasing whilst the strategic importance of cluster organizations increases. This is evident as, particularly, new cross-sectoral co-operations are increasingly being developed among partners that share close geographic proximities, despite a potential for more internationalisation. As a result, policy makers are increasingly providing more tailor-made guidance, especially regional programs. Policy initiatives, intended to guide the innovation related investments, are catalysts for cluster development, but require collaborative efforts between public and private actors (Teigland and Lindqvist, 2007; Köcker and Müller, 2015).

Theoretical advances in the understanding of innovation processes and their contribution to economic growth (OECD, 1999) have pointed to a need to revisit the rationale of science, technology and innovation policies (OECD, 1998d). In my approach I focus on the linkage and interdependencies between actors in the network whose interactions determine innovative performance builds on a relatively young modern innovation approach, national systems of innovation.

2.2 National Systems of Innovation

In a response to criticism that for decades economists have failed to integrate institutions into their theories and econometric models, scholars in the field of science, technology, and innovation developed the national systems of innovation approach (Nelson and Winter, 1977; Nelson 1981; Godin 2007). National systems of innovation, perhaps the broadest approach to economic performance at the country level (Acs et al., 2016), frames innovation activities and the way firms interact within an innovation and institutional context (Freeman, 1987; Edquist and Lundvall 1993; Filippetti and Archibugi 2011, Acs et al. 2014; Leyden 2016; Leyden and Link 2015a, b). This interaction between a network of interconnected institutions creates, stores and transfers knowledge, skills and artefacts which defines a nation's capacity to innovate and upgrade (Porter, 1990; Nelson, 1993, Metcalfe, 1995).

Recently, the approach has become a popular framework in literature to discuss a systematic approach to technological innovation, but the basic ideas behind the concept goes back to Friedrich List (*Das nationale system des politischen Okonomie*, 1841) who anticipated contemporary theories of national systems of innovation (Lundvall, 2004; Soete et al., 2009). This relatively new approach for policy makers started taking shape after Freeman's "*The economics of Industrial Innovation"* (1974). In the 1970's Freeman observes a radically changing world with changing values and new priorities which would require a shift towards social and technologically focused innovation. The challenge for policy makers was to articulate new demands in such a way that the system actors could respond effectively (Freeman 1974). To better understand how such response could be coordinated at a national level Nelson introduced the concept of National Systems of Innovation in 1993: "a set of institutions whose interactions determine the innovation performance of national firms" (Nelson, 1993).

Framework

Nelson's framework was based on Neo-Schumpeterian innovation economics (Nelson and Winter, 1982) and is based on the important role of tacit knowledge, the bounded rational of economic agents, and the role institutional settings play in economic activities (Acs et al., 2016). The framework rests on three well established assumptions (Filippetti and Archibugi, 2011);

- Countries exhibit systematic difference in terms of economic performance.
- Economic development not only depends on technological and innovation capabilities but also on the development of institutions.

- Innovation and technology policies are an effective tool for fostering and shaping the performance of countries.

Thus the National Systems of Innovation framework incorporates "the nature of scientific and technological institutions, the education, research, apprenticeship, and training system, the financial system, the structure of the industry and labor market, but also institutions to shape and foster innovative activities like tax systems, incentives on the individual and firm level, the protection of intellectual property rights, among others" (Hall and Soskice 2001; Fagerberg et al. 2009; Hall et al. 2014, Acs et al., 2016). Later in this paper I will identify the main dimensions that determine the nature of regional innovation and business ecosystems which will make up my conceptual framework.

Clustering & NSI

The development of an effective industrial policy generally focusses on creating favourable framework conditions through an interactive process between firms and relevant government agencies rather distinguishing between individual firms (Lankhuizen and Woolthuis, 2003). The concept of national systems of innovation has influenced the rationales for cluster policy as modern cluster policies in OECD-countries focusses on the network linkages and environment rather than on individual firms (Verbeek, 1999). In my analysis I will apply the conceptual framework of the national systems of innovation approach in analysing cluster organisations, an important source of economic development and competitive advantage. I will do so by identifying key dimensions where the NSI approach and cluster policy overlap. Quantifying the dynamics of these dimensions allows for an empirical study. In the next section will further define cluster organizations as to tailor the approach.

2.3 Cluster Organizations

There is a strategic importance for companies to establish networks which create inter-firm collaboration (Asheim, 1999), but also to remain ahead of competition by gaining the flexibility to act rapidly on innovations (Porter, 1998a). Storper (1989) recognized that clustered firms have the ability to quickly shift between processes and products and build together on organizational change but the conditions needed for this unique way of doing business, have to be facilitated (Verzijl, 2013).

The purpose of cluster organizations is to promote economic development within the cluster by improving the competitiveness of one or several specific business sectors, the business environment, supporting innovation and collaboration among cluster actors, and facilitating the attraction of external resources such as (foreign) investment, human resources, and financial capital, all of which are

instrumental in enhancing the competitive advantage of clusters (Lindqvist, 2009; Burger et al., 2014). More specifically, cluster initiatives are projects or programs developed by cluster organizations in an organized effort to enhance the competitive advantage and growth of clusters and to facilitate collaboration between a diverse number of public and private sector cluster actors, such as firms, government agencies, and academic institutions (Sölvell et al., 2003; Teigland and Lindqvist, 2007; Burger et al., 2014). Furthermore, measuring the quality of governance measures to the extent to which national and regional policy-makers work in an impartial and incorrupt manner (Charron et al., 2014). It is important to include this dimension since several studies have revealed that there is a positive relation between low levels of quality of governance (high levels of corruption and weak rule of law) with low levels of economic development (Mauro, 2004), this will be discussed further in chapter 3.

Cluster organizations function as an intermediary or platform which facilitates knowledge sharing and initiates collaboration (Lindqvist, 2009; Ketels et al., 2012; Laur et al., 2012). Consequently, cluster organizations and their initiatives facilitate innovation and growth drivers of firms located in clusters. These firms account for more than 87 % of all patents in the United States (Delgado et al., 2014), report much higher productivity, wages, and productivity growth (Porter, 2003), and their growth potential is not limited by the size of any local market. Cluster organizations and their initiatives should be a top priority on the agendas of regional and national policy-makers.

Cluster Organization Activities

Cluster organizations provide a wide range of activities as policy objectives vary significantly across regions. Activities includes coordinating cluster actors their access to capital investments (Powell et al., 2002), lobbying with governmental bodies (Porter, 2000; Gallié et al., 2012), facilitating communication networks and the exploitation of new business models (Sölvell and Williams, 2013). Still, cluster organizations mainly act as innovation support providers by channelling specialised and tailor-made business support services to stimulate innovation activities (c.f. Benneworth et al., 2003, Sölvell et al., 2003; Lindqvist, 2009; Coletti, 2010; Glaser, 2013). Cluster organizations look beyond sectoral, geographical and departmental desires in facilitating strategic partnering, between cluster actors and with external parties across sectors. These activities enhance the competitive advantage of cluster actors and are particularly effective for small and medium enterprises (Ketels et al., 2012; Laur et al., 2012). Cluster organization activities can be distinguished by three main categories; support and engage in networking activities, cluster promotion activities (also branding, and business development) and the

facilitation of cluster innovativeness (Isaksen and Hauge, 2002; Ketels et al., 2012; Sölvell and Williams, 2013; Lindqvist et al., 2013; Skålholt and Thune, 2014; Burger et al., 2015).

Networking activities focus on efficient communication and the establishment of a common identity between cluster actors (Raines, 2002). Cluster organizations create a platform where cluster actors can discuss mutually beneficial efforts, issues, and business activities, exchange ideas and initiate collaboration (Lindqvist, 2009; Ketels et al., 2012; Laur et al., 2012). By creating a common identity, promotional activities increase the clusters' attractiveness which raises the potential of drawing new firms and human capital to the cluster (Burger et al., 2015). This in turn increases the clusters' potential knowledge spill over effects, the probability of attracting foreign investment (Hejazi and Safarian, 1999; Branstetter, 2006), contributes directly to cluster innovativeness, stimulates export promotion (Sölvell et al., 2003) and the integration into global commodity chains (Birch, 2008). Finally, the facilitation of innovativeness has the goal of improving the specific R&D environment within the cluster (Burger et al., 2015). Cluster organizations do so through collecting and analysing market intelligence, encouraging the diffusion of new technologies and organize training, education and research programs (Isaksen and Hauge, 2002; Lindqvist and Power, 2002; Sölvell et al., 2003; Burger et al., 2015).

2.4 Variation in Numbers

Cluster organizations facilitate the coordination of cluster actors through initiatives which can vary significantly across regions. In this sub chapter I will look into the variance in the number of cluster organizations and bases on a cluster mapping approach I will identify relevant regional determinants, based on the national system of innovation approach, which could justify this variation.

Cluster organizations can have significant impact on the regional economy, its competitive advantage and the growth of innovation. Their effectiveness depends on the initiatives they undertake and the degree of competition between clusters (Isaksen and Hauge, 2002). To explain more on this topic we look at top-down cluster policies. As public cluster actors often times have higher expectations from cluster initiatives than private sector actors do (Teigland and Lindqvist, 2007), policy-makers run the risk of overestimating the impact from cluster policies. Furthermore, policy-makers are often unaware that mimicking cluster development policies, at a regional level, results in the overinvestment or the misallocation of funds, particularly in economic or clustering activities (Storper, 1995; Jacobs and De Man, 1996; Hospers and Beugelsdijk, 2002; Burger et al., 2014).

Recent studies have revealed shortcomings in studying regional cluster policies as large per cluster differences in geographic scale, structure and content which could indicate the difficulty in comparing cluster policies internationally (Kusters and Minne, 1992). Porter's sectoral mega clusters approach (Porter, 1990) was a breakthrough, it standardizes beyond the traditional boundaries which divided primary (raw materials), secondary (manufacturing) and tertiary (services) sectors (Verbeek, 1999) and indicated what innovation and specialization patterns are. However, dominant structural characteristics are yet to be found (Gordon and McCann, 2000).

Cluster & Cluster Organization Mapping

Recent studies into the functionality and sectoral substitutability of cluster organizations revealed a considerable degree of regional variation in the number of cluster organizations across the European life sciences industry (Burger et al., 2014). An initial comprehensive geographical examination of the heterogeneity of cluster organizations pointed out that there were significant differences between the various regions studied but the degree of variation has not been justified. To facilitate policy-makers and their corresponding cluster organizations, insights into regional determinants to this degree of variation may be valuable. Therefore, an understanding of the location of and competition between coordinated clusters (Burger et al., 2014) is crucial. An empirical study on regional performance indicators will provide rich insights into the regional variation. Mentioned by Burger et al. (2014), policy makers benefit from this as it allows for more goal-directed and effective strategic planning with regard to regional cluster policies and long-term regional economic development (Porter, 2000; Ketels et al., 2012).

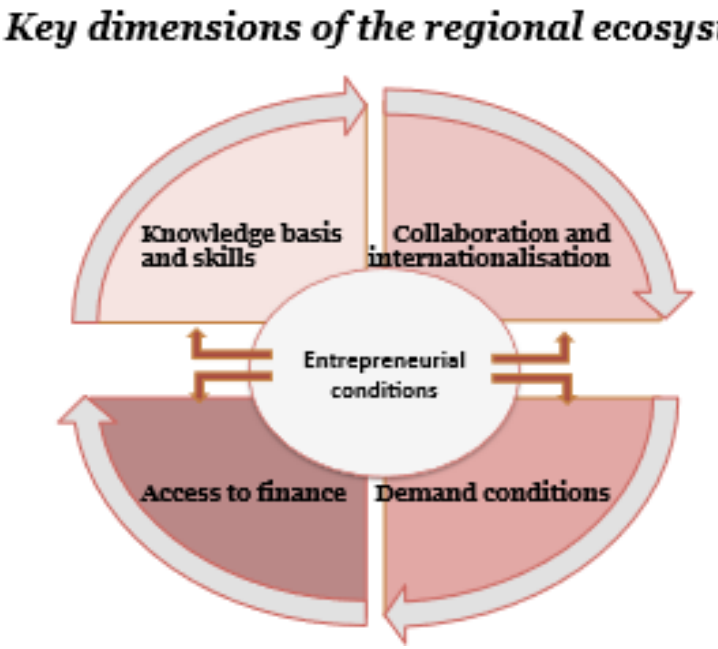
The approach I use in my paper is comparable cluster mapping which places cluster data into a broader context of other cluster- and location-specific data relevant for the competitiveness of the clusters. This approach, combined with cluster theory and the national systems of innovation approach enables a fact-driven shift from industrial and regional policies focused on backing laggards to an integrated economic development policy organized around 'strengthening strengths' in all regions (Ketels and Protsiv, 2014).

2.5 Regional Determinants

The European Commission has launched a range of initiatives to foster innovation and growth, and to strengthen the underlying competitiveness of the European economy. Clustering and a national systems of innovation approach align with their overall goal; fostering policy-making for sustainable, smart and inclusive growth and that is where clusters come in. In clusters companies tend to grow faster, be more innovative and create more jobs which makes them an important tool in implementing regional, national and European policy (Bieńkowska and Creţu, 2016). For this reason the EC founded the

European Cluster Observatory (ECO) in 2006, an analytical tool to support policymakers, at European, national and regional levels, and cluster managers in developing cross-sectoral co-operation. According to the ECO, key dimensions that determine the nature of regional innovation and business ecosystems are the regions knowledge basis and skills, access to finance, collaboration and internationalisation, demand conditions and entrepreneurial conditions. These dimensions reflect on the conditions of the ecosystem that have an impact on industry and business dynamics (León et al., 2016) and have been synthesized into a conceptual framework which for a large part relates to the national systems of innovation approach.

Figure 1: Conceptual model: dimensions of region-specific framework conditions (Izsak and León, 2016)[1]



[1] http://ec.europa.eu/growth/smes/cluster/observatory/regional-ecosystem-scoreboard/index_en.htm

Knowledge basis and skills and the access to finance are two critical dimensions as human capital and financial assets are key drivers for economic growth (OECD, 1996, the knowledge based economy). Due to the increasing importance of skills in the knowledge-based global society and the tackling of the financial gap (OECD, 2012) these are two primary dimensions. The knowledge basis and skills dimension focuses on (higher) education, human capital training, development, and the availability of skilled human resources whilst the access to finance looks into issues related to the availability of private and public funds within a region (León et al., 2016). A recent OECD report (OECD, 2012) highlighted the increasing importance of skills in a knowledge-based global economy. Furthermore, for firms to become more productive and competitive the knowledge basis should be expanded (León et al., 2016). As the quality of knowledge and skills within a region increases, I expect the demand for these qualities to be shared, increasing the knowledge basis, to increase. Henceforth, as their quality increases the demand for institutions to facilitate knowledge flows would also increase;

Hypothesis 1: the quality of the knowledge basis and skills within a region is positively related to the number of cluster organizations the region hosts

Access to capital has been compromised by the global financial crisis, which particularly hit high-growth and innovative firms as availability of financing. As access to and the conditions for credit have worsened this has become a major challenge for the creation, survival and growth of firms. Most of the recent economic literature on economic growth, innovation and entrepreneurship take into account the financing of innovation/growth and access to capital (finance), which deals with the presence of actors to provide funds and the availability of financial resources (equity and debt) (León et al., 2016). As the accessibility of finance at a regional level decreases and the financial gap (situation where a share of enterprises cannot obtain financing) increases I would expect an increase in the demand for assistance in financing. Due to a limited amount of literature available, this hypothesis is based on this logic:

Hypothesis 2: the availability and access to finance within a region is negatively related to the number of cluster organizations the region hosts.

Clusters are characterized by intensive collaboration between public and private sectors enabling knowledge transfer. This in turn directly reflects the degree of connectivity and collaboration between knowledge institutions, such as universities, private, and public sector actors. Intense collaboration within a cluster enables a region to build a novel industrial profile through which it creates a momentum for new cluster formation or transformation (Trippl et al., 2014). The Regional Ecosystem Scoreboard differentiates collaboration through general system linages, specialization, cross-sectoral linkages, and the openness to extra-regional knowledge-flows (León et al., 2016). In essence the degree of collaboration and internationalisation of knowledge flows is used to measure the level of knowledge transfer between knowledge institutions and the industry in the region. This is due to the fact that a key aspect of cluster organizations is the platform it offers to initiate contact and collaboration between cluster actors. Cluster organizations facilitate interaction and hence are an effective measure in stimulating collaboration between cluster actors when this is missing (Burger et al. 2015). Hence, as the degree of collaboration between cluster actors increases it would seem logical to assume that there is less demand for a platform to stimulate collaboration. In regions where collaboration between actors is limited the creation of such a platform could be highly effective. Hence;

Hypothesis 3: the degree of collaboration & internationalisation of knowledge flows between cluster system actors, is negatively related to the number of cluster organizations the region hosts.

Innovation is the ability to manage knowledge creatively in response to market-articulated demands and other social needs (OECD, 1999). An enterprise's performance, as a main source of innovation, depends on incentives provided by the economic environment, their access to critical inputs and their internal capacity to seize market opportunities. Market transformation, as a result from the radically changing world described by Freeman (1974), alters the behaviour of market actors and creates a specific demand for innovation (León et al., 2016). The nature of both, private and public demand, and the role of lead users, individuals or organizations that express needs for innovation, can stimulate innovativeness of the region as competitiveness of firms stimulates innovation (Von Hippel, 1986; Izsak and Edler, 2011). In the context of national systems of innovation, I differentiate between public and private demand factors and look into patterns of buyer's sophistication, lead user patterns, market dynamics and demand-related factors that the public sector can stimulate through policy. I predict that in regions where the level of demand is high there is less demand to stimulate coordinating, facilitating or lobbying activities;

Hypothesis 4: a high level of demand, including both private and public demand, within a region is negatively related to the number of cluster organizations the region hosts.

Moreover, entrepreneurship promotes innovation at a regional level through clusters as they stimulate regional industrial change, adaptation and self-organization (Feldman, 2005). The correlation between entrepreneurship, a mix of entrepreneurial attitudes, activities and aspirations (Acs et al., 2009) and economic development is not as straight forward as we would hope. Literature has pointed out the difficulty of establishing cross-sector dynamics and describing the role of entrepreneurship. However, conditions of entrepreneurship are been clearly established as being influenced by institutional frameworks for doing business and culture. Both can foster or act as a barrier to entrepreneurs (León et al., 2016). In my approach, entrepreneurial conditions capture the ease of doing business, infrastructure and entrepreneurial culture within regions. As the entrepreneurial conditions improve, there may be less need for cluster organizations to drive industrial change. Hence, I expect that;

Hypothesis 5: entrepreneurial conditions of the institutional framework for doing business in the region are negatively related to the number of cluster organizations the region hosts.

In my systematic approach I consider not only the strengths and weaknesses of regional and national ecosystems. The five dimensions capture the overall quality of the regional entrepreneurial and innovation ecosystem which provides valuable insights into the regional conditions which can identify determinants of the variance in the number of cluster organizations across the European Union.

Chapter 3. Data Description & Methodology

In my econometric model, the number of cluster organizations hosted by a region, specified at the NUTS-2[2] level, is taken as the dependent variable. The number of cluster organizations in a region is not necessarily indicative of the quality of these cluster organizations or the funds that they have available to pursue their activities, it is indicative of how active a region is in promoting the development of a cluster (Burger et al., 2015).

3.1. Cluster Organizations Data

Count data on the number of cluster organizations in a region was obtained from survey data (Burger et al., 2015) which has been aggregated at a regional, NUTS-2 level. The data was initially collected to assess the importance of cluster organizations in strengthening the competitive advantages of clusters and distinguishing the policies that formal cluster initiatives implement to improve the attractiveness of clusters to FDI. In this paper I will use their research and data in parallel to the national systems of innovation approach and the conceptual framework which will later be explained in this chapter. Whereas it might be ideal to have data on all cluster organizations in the European Union, comparable data is not available as is denoted in Burger et al. (2015). They surveyed 230 cluster organizations in the West-European life sciences industry previously identified in the databases of the European Cluster Observatory (ECO), the Council of European BioRegions (CEBR), Cluster-Collaboration, and the European Secretariat for Cluster Analysis (ESCA). To identify the life sciences industry pharmaceuticals, medical devices, biotechnology, and healthcare were incorporated.

Given that not all countries have many life science clusters, risk of item-non-response was minimized by increasing the response rate by asking the straightforward open-ended and scaled questions. Initially cluster organizations were approached via e-mail, including an online survey and non-respondents were reminded up to ten times. Of the 230 identified cluster organizations in the European life sciences sector, 148 from 16 different countries responded, a response rate of 65 per cent. A first glance at the data reveals some promising insights, table 1 displays descriptive statistics of variables included in the baseline regressions.

[2] The NUTS classification (Nomenclature of Territorial Units for Statistics) is a hierarchical system for dividing up the economic territory of the EU for the purpose of framing EU policies, socio-economic analyses of regions and the collection, development and harmonization of European regional statistics. NUTS-2 regions are regarded as basic regions for the application of regional policies. Source - http://ec.europa.eu/Eurostat/nuts/overview

Table 1: Descriptive Statistics of Variables

Variable	Description	Mean	SD
Number of Cluster Organizations	The Number of Cluster Organizations in a Region	1.05	1.45
ln(GDP per Capita)	The Natural Logarithm of the GDP Per Capita of the Region	10.03	0.35
ln(Number of Employees)	The Natural Logarithm of Number of Employee in a Region	7.65	1.71
Employee Compensation	Average Employee Compensation of a Region	30738	8252
ln(Corporate Tax)	The Natural Logarithm of the Corporate Taxes in a Region	-1.25	0.13
ln(Quality of Governance)	The Natural Logarithm of the Quality of Governance of a Region	-0.76	0.48
ln(Regional Accessibility)	The Natural Logarithm of a Region's Degree of Accessibility	4.52	0.35
ln(Knowledge Dimension)	The Natural Logarithm of a Region's Knowledge & Skills Indicator	-0.90	0.28
ln(Access to Finance Dimension)	The Natural Logarithm of a Region's Access to Finance Indicator	-1.02	0.34
ln(Collaboration Dimension)	The Natural Logarithm of a Region's Collaboration & Internationalization Indicator	-0.89	0.27
ln(Demand Conditions Dimension)	The Natural Logarithm of a Region's Demand Condition Indicator	-0.96	0.29
ln(Entrepreneurial Conditions Dimension)	The Natural Logarithm of a Region's Entrepreneurial Conditions Indicator	-0.66	0.27
ln(Quality of Human Resources)	The Natural Logarithm of a Region's Human Resources Indicator	-0.96	0.39
ln(Availability of Training & Learning)	The Natural Logarithm of a Region's Lifelong Learning Indicator	-0.61	0.39
ln(Availability and Quality of Skills)	The Natural Logarithm of a Region's Skills Indicator	-1.36	0.44
ln(Attitude of regional investors and private finance)	The Natural Logarithm of a Region's Attitudes of Private Funding Indicator	-0.72	0.41
ln(Legal Framework for Finance)	The Natural Logarithm of a Region's Access to Finance Legal Framework Indicator	-1.10	0.64
ln(Availability Public Funds)	The Natural Logarithm of a Region's Availability of Public Funds Indicator	-1.36	1.14
Support from Structural Funds	A Region's Support from Structural Funds Indicator	0.41	0.14
ln(Degree of General System Linkages)	The Natural Logarithm of a Region's General System Linkages Indicator	-0.79	0.38
ln(Degree of Cross-Sectoral Linkages)	The Natural Logarithm of a Region's Cross-Sectoral Linkages Indicator	-0.99	0.38
ln(Degree of Specialization)	The Natural Logarithm of a Region's Specialization Indicator	-0.90	0.32
ln(Openness of the Region)	The Natural Logarithm of a Region's Openness Indicator	-0.95	0.37
Private Demand Conditions	A Region's Private Demand Indicator	0.42	0.08
Public Demand Conditions	A Region's Public Demand Indicator	0.37	0.15
ln(Quality of New Business Regulatory Framework)	The Natural Logarithm of a Region's Startup Regulatory Framework Indicator	-0.44	0.23
Quality of Entrepreneurial Culture	A Region's Entrepreneurial culture Indicator	0.45	0.13
Regional attractiveness & quality of infrastructure	Attractiveness of the Region and Quality of Infrastructure Indicator	0.48	0.17

The survey discloses useful information regarding the characteristics of cluster initiatives with respect to size, funding data, and funding sources. Such information will be referenced to further on in this chapter. It was found that cluster organizations are present in 52 per cent of the 222 West-European NUTS-2 regions in this database. This number seems rather low, however, in 7 NUTS-regions there are already more than 5 cluster organizations present. Of the cluster organizations that responded to the survey, over two-thirds were established in the period 2000–2010. For cluster organizations that did not ultimately respond, numerous attempts were made to obtain data on their promotion and financing activities through their websites and annual reports. In the event that no website was available, the cluster initiative was classified as non-existent and dropped from the database.

3.2. Key Dimension

The European Cluster Observatory (ECO) serves as a single access point for statistical information, analysis and mapping of clusters and cluster policy in Europe and is primarily used to identify regional specialization patterns which provides policy makers insights into where they can best invest public money. Combining survey data from Burger et al. (2015) with a cluster mapping strategy will provide insights into regional competitiveness and the concentration of economic activities by delivering an overview of sectoral and cross-sectoral regional data.

Recently, May 2016, the European Cluster Observatory published a new tool, the Regional Ecosystem Scoreboard (RES). The RES aims to capture the regional and cluster specific framework conditions that can help to foster the emergence of new industries and clusters in the economy, similar to the National Systems of Innovation approach (Nelson, 1993) mentioned in previous chapters. The scoreboard is composed of both statistical indicators (secondary sourcing) and experiments with new types of indicators based on firm-level data that can capture dynamics in the region. The RES is designed to help regional policy-makers identify, describe, and capture the quality of conditions in the regional ecosystem that can foster or hinder the creation of dynamic cross-sectoral collaboration spaces (León et al., 2016). Principally, cluster policy facilitates the development of clusters that develop economic activities that are aligned with regional economic and institutional structures (Hospers et al., 2009; Ketels et al., 2012, Burger et al., 2015). Hence, the RES can reveal both enabling and constraining mechanisms, but must always be interpreted in the light of the regional cluster policy and regional economic conditions.

In broader context, data presented in the RED makes a crucial contribution to help decision-makers across Europe. It reflects on cross-sectoral differences that affect the location of economic activities. The

RES makes it possible for policy-makers to effectively use cluster data when developing cluster policies which set priorities for areas based on capabilities, cross-sectoral, and regional comparisons. Its ultimate objective is to help cluster actors and policy-makers to design smart specialization and cluster growth strategies that will help cluster actors to develop new, globally competitive advantages. This is in line with the national systems of innovation approach.

The RES provides policy-makers with insights into framework conditions and dynamics, but does not measure the performance of a cluster. Other related regional scoreboards (such as the Regional Innovation Scoreboard, US Cluster Mapping, OECD Entrepreneurial Index, and the Regional Competitiveness Index) predominantly focused on measuring innovation performance, focused on sectors, industries, clusters, and entrepreneurship or focused on territorial competitiveness. The Regional Ecosystem Scoreboard is able to effectively combine the above into one framework. Consequently, the Regional Ecosystem Scoreboard is a great comparative tool for evidence-based analysis into the regional variation in the number of cluster organizations across the European Union.

Regional Ecosystem Scoreboard as mentioned in chapter 2, identifies key dimensions that determine the nature of regional innovation and business ecosystems;

- Knowledge basis and skills
- Access to Finance
- Collaboration and Internationalisation
- Demand Conditions
- Entrepreneurial Conditions

Seventeen sub-dimensions, that determine the quality of conditions of regional ecosystems, make up the 6 key dimensions. These in turn, are built on 58 individual indicators which are selected based on the OCE's review of literature and an assessment of available indicators to reflect on the conditions of the ecosystem that have an impact on industry and business dynamics (León et al., 2016).

It is evident that the indicators which make up the Knowledge Basis and Skills dimension focus on (higher) education, human capital development and training, and the availability of skilled human resources in a region. The knowledge basis and skills dimension includes 10 indicators which fall under three key aspects of the dimension. First (K1), the availability and quality of human resources alongside the infrastructure to train regional human resources. Second (K2), the availability of vocational training and life-long learning which measure a region's ability to adapt to changes and renew the quality of its

human capital resources. Third (K3), the capacity of the private sector to respond to changes in the marker, become more innovative and maintain its competitiveness is driven by the availability of skills in the private sector.

The dimension Access to Finance looks into issues related to the availability of private financing and public funds as well as the legal framework available to support access to finance. As a whole, all 8 indicators should provide a good picture of the ease of accessing funding by enterprises at regional level.

As knowledge transfers are most certainly not bound by specific regional boundaries in this digital age, the collaboration dimension also looks into Internationalisation of collaboration. Hence, Collaboration and Internationalisation investigates the connectedness of regional actors to a geographically broader knowledge and innovation network. The dimension measures the level of knowledge transfer between academic institutions and the industry actors in an attempt to provide insights into the availability of knowledge transfer mechanisms. 15 indicators have been selected according to different types of knowledge linkages that can exist among innovation. Some indicators capture regional knowledge flows as they are related to knowledge spill overs and connectedness. Furthermore a regions openness contributes to the flow of new ideas entrepreneurship.

The Entrepreneurial Conditions dimension does not capture quality of entrepreneurship in a region. It rather captures framework conditions under which entrepreneurship can thrive. Indicators that can capture entrepreneurial conditions include the ease, infrastructure and culture of business creation in a region. Similarly the Demand Conditions dimension differentiates between private and public demand factors, looks into specific patterns in buyer sophistication, lead users, market dynamics and other demand-related factors.

Ten of the 58 indicators are based on results of a survey which was conducted, by the European Cluster Observatory, among cluster managers and regional policy-makers in the period September 2015-October 2015. The objective of the survey was to collect data for the set of 10 indicators for which secondary data was not available. By doing this the ECO increased the coverage and robustness. Furthermore, the weight applied to these ten indicators is based on the reciprocal of the regional response rate on the questionnaire.

The inclusion of data for the 48 remaining indicators required data to be available for all indicators and for all regions. Data imputation techniques were implemented to increase data availability at the regional level. Techniques used were tested and implemented broadly in other EU Scoreboard initiatives

such as the Innovation Union Scoreboard and the Regional Innovation Scoreboard. After the imputation of missing data, the composite indicators were established for the 16 sub-dimensions after the range and scale of all indicators were standardized using the mixture-maximum estimation procedure (Keich et al., 2015). Additionally, robustness tests were performed on individual indicators to test whether the correlation between sub-dimension composite scores varied significantly within the data, but the variation of overall composite index scores did not vary significantly (León et al., 2016).

Table 2 is a correlation table of main variables included in the analyses and table 3 presents an overview of the 16 sub-dimensions which make up the regional ecosystem scoreboard. Furthermore the 5 key dimensions are the main independent variables which form the basis of the conceptual framework as they capture the quality of conditions in the regional ecosystem. The combination of these two datasets will, in particular, reflect on the earlier mentioned national systems of innovation.

Table 2: Correlation Table of the Main Control Variables & the Conceptual Model's Dimensions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) Number of cluster organizations	1.00											
(2) Ln GDP per Capita	0.10	1.00										
(3) Ln Number of Employees in Clusters	0.38	0.41	1.00									
(4) Ln Employee Compensation	0.22	0.57	0.21	1.00								
(5) Ln Corporate Tax	0.15	-0.07	0.13	0.08	1.00							
(6) Ln Quality of Governance	-0.01	0.23	0.10	-0.03	-0.04	1.00						
(7) Ln Accessibility	0.20	0.66	0.54	0.43	0.18	0.22	1.00					
(8) Ln Entrepreneurial Conditions Dimension	0.09	0.71	0.50	0.45	0.05	0.27	0.62	1.00				
(9) Ln Collaboration Dimension	0.11	0.55	0.48	0.16	0.01	0.37	0.58	0.72	1.00			
(10) Ln Knowledge Dimension	0.24	0.64	0.48	0.59	0.16	0.08	0.53	0.72	0.64	1.00		
(11) Ln Demand Conditions Dimension	-0.07	0.45	0.33	0.08	0.08	0.16	0.31	0.56	0.56	0.60	1.00	
(12)Ln Access to Finance	0.19	0.47	0.41	0.47	0.45	0.10	0.46	0.67	0.55	0.82	0.50	1.00

Table 3: Overview of Indicators

Dimension	Sub Dimension
E - Entrepreneurial Conditions	E1 - Regulatory framework for starting a business
	E2 - Entrepreneurial culture
	E3 - Attractiveness of the region and quality of infrastructure
K - Knowledge basis and skills	K1 - Human resources
	K2 - Vocational training and lifelong learning
	K3 - Skills
C - Collaboration and Internationalisation	C1 - General system linkages
	C2 - Cross-sectoral linkages
	C3 - Specialization
	C4 - Openness of the region
F - Access to finance	F1 - Attitudes of investors and private financing
	F2 - Legal framework support-ing access to finance
	F3 - Availability of funds from public sector
	F4 - Support from Structural Funds
D - Demand Conditions	D1 - Private demand
	D2 - Public demand

3.3. Matching Problem

It is important to note that the data retrieved from the European Cluster Observatory only covered Belgium, Germany, and the United Kingdom at a NUTS-1 level. As regional data is missing I used the same approach which the ECO used to impute missing data. The imputation technique used by the European Cluster Observatory has been tested and implemented broadly in other European Union Scoreboard initiatives.[3] When regional data is missing for both the previous and following year and higher level correlated indicators were missing, they replace missing regional data with higher level aggregated data. As such, missing data for NUTS-2 regions in Belgium, Germany and the United Kingdom were imputed using NUTS-1 data from the regional ecosystem scoreboard. To do so the European Commission's NUTS-classification was used to attribute Belgium's 3 NUTS-1 scores to the corresponding 8 NUTS-2 regions. In Germany 16 NUTS-1 scores were allocated to 39 NUTS-2 regions and in the UK 31 NUTS-1 scores were allocated to 89 NUTS-2 regions, using the same technique.

Furthermore, NUTS-2 classifications of Finland changed from in 2010. Count data on the number of cluster organizations in a region obtained from survey data (Burger et al., 2015) classified Finland's

[3] Such as the Innovation Union Scoreboard (ec.europa.eu/enterprise/policies/innovation/files/ius/ius-2014_en.pdf) & the Regional Innovation Scoreboard (http://ec.europa.eu/news/pdf/2014_regional_union_scoreboard_en.pdf).

NUTS-2 regions based on the pre-2010 NUTS-2 classification whilst the European Cluster observatory classified Finland's NUTS-2 regions using post-2020 NUTS-2 classifications.

To test for the impact of matching problems, I will perform a robustness check to test the reliability of the results. The robustness check will be performed by omitting observations from NUTS-2 regions in Belgium, Finland, Germany, and the United Kingdom from the dataset, after which identical the new dataset will follow the same econometric approach as will be explained below.

3.4. Control Variables

In order to control for factors that may influence the number of cluster organizations hosted in a region I added data the following variables: quality of governance, the number of employees in a cluster, a region's accessibility, population size, GDP per capita, the presence of international organizations, average employee compensation and the level of corporate tax in a region.

The extent to which national or regional administrators perform their activities in an impartial and incorrupt manner (Charron et al., 2014), is measured through integrating the European funded ANTICORP European Quality of Government Index. The index captures the quality of the regional regulatory environment, rule of law, government effect and that of the product market regulation (León et al., 2016). The Index is based on survey data at the NUTS-2 regional level within the EU, conducted first in 2010 and then again in 2013. Quality of Governance is an important control variable since several studies have identified a positive correlation between low quality of governance with low-level of economic development (Mauro 2004). Low- quality of governance can hinder innovation as actors are confronted with obstacles that cannot be overcome unless the institutional frameworks change (Rothstein and Teorell, 2008). The above-mentioned indexes and will be a proxy for the quality of governance in the regional benchmarking.

The contrast in scale between regional clusters and their relevant markets is a point for attention (Verbeek, 1999). Cluster size and location significantly affect a firm's ability to formalize knowledge transfer (Spielkamp and Vopel, 1999). Geographic proximity is less important for searching and finding knowledge in innovation-related areas, but for smaller companies geographic proximity becomes more important (Lankhuizen and Woolthuis, 2003). Furthermore, empirical analysis by Lankhuizen and Woolthuis (2003) has shown that co-operation deceases with company size. In order to control for the possible effect of size and setting on the number of cluster organizations hosted by a region I control for the number of employees working in a cluster and a region's accessibility.

Furthermore, population size and GDP per capita are positively related to the demand for goods and services. Moreover, when a country is more open to trade, it is more inclined to be competitive. Therefore, GDP per capita, population size and the presence of international organizations, a proxy for openness to trade, are controlled for. To control for variance in innovation expenditure and corporate strategy, which may influence innovation strategies, I control for employee compensation, a proxy for investment in human capital (a dimension of corporate strategy) and corporate tax (which can influence location decisions of innovative firms). Data on these control variables was retrieved from the survey results from Burger et al. (2015). Also, country fixed effects are often included to capture the systematic difference in the number of cluster organizations across countries. However, after testing the impact of country fixed effects, the conceptual model no longer showed any significant results to justify the regional variation in the number of cluster organizations.

3.5. Methodology

Having created the dataset I am now able to quantify the regional characteristics which may justify the regional variation in the number of cluster organizations. I will now elaborate on the estimation strategy and methodology which will investigate possible dimensions to explain the significant regional variation in the number of cluster organizations across 15 EU countries.

Econometric Model

Perhaps the most common technique to model count data is a Poisson regression. Poisson distribution provides an approximation to the binomial for the analysis of events (Rodríguez, 2007). One of the key assumptions of Poisson distribution is that the variance of the dependent variable equals the mean, empirically, however, we often find data that exhibit over-dispersion, with a variance larger than the mean (Rodríguez, 2007). Performing a goodness-of-fit for log-linear models tests the deviance in the mean and variance of the dependent variable which gives insight into whether a Poisson Model for distribution is too restrictive for the regression.

A negative binomial regression is the popular generalization of a Poisson regression because it loosens this highly restrictive assumption. The negative binomial model can be seen as a Poisson regression model with an added multiplicative random effect, to represent unobserved heterogeneity (Rodríguez, 2013). Outputs generated in Stata for both models provides estimates that are very similar (see the Results chapter) to the Poisson model, vital though is that for all models of my approach the Poisson model does not pass the goodness-of-fit test. Hence, in all cases a negative binomial model is used. Furthermore, the regression coefficients presented in the tables are marginal effects, additive

approximations of effects in non-additive models. In the case of count data, marginal effects for continuous variables measure the instantaneous rate of change. Marginal effects provide a good approximation to the amount of change in the dependent variable due to a 1-unit change in the independent variable. When interpreting coefficients, a coefficient of 0.07 corresponds to a 7 percentage point increase in the number of cluster organizations due to a 1 percent increase of the corresponding independent variable. .

The baseline model will test my hypotheses whilst the remaining models will provide insights into the significance of sub-indicators. Where 'NCO' denotes the mean number of cluster organizations hosted across EU NUTS-2 regions, 'K' is knowledge basis and skills dimension, 'F' the access to finance, 'C' the degree of collaboration and internationalisation, 'D' demand conditions and 'E' the entrepreneurial conditions. As none of the independent variables passed the Skewness and Kurtosis test for normal distribution, they were transformed to the natural logarithm. The same applies for the control variables, apart from employee compensation. Additionally, the error term captures any variation unobserved by the other independent variables.

Equation 1:

$$NCO = \beta_0 + \beta_1 \ln(K) + \beta_2 \ln(F) + \beta_3 \ln(C) + \beta_4 \ln(D) + \beta_5 \ln(E) + \beta_6 \ln(GDP\ Per\ Capita) + \beta_7 \ln(Employee) + \beta_8 EmployeeCompensation + \beta_9 \ln(CoporateTax) + \beta_{10} \ln(QualityOfGovernance) + \beta_{11} \ln(Access) + \varepsilon$$

Cluster of Policies

For further insight I test the 16 sub-dimensions in order to gain an understanding of the mechanism behind cluster policies. The aim of the following section is to investigate whether cluster aimed policy mixes are rather "clusters of policies" than "cluster policies" (Nauwelaers and Wintjes 2008).

The dependent variable (NCO) is the number of cluster organizations in the life sciences industry across NUTS-2 regions in 15 EU countries. Equation 2 tests the significance of the three sub-dimensions of the Knowledge Basis and Skills dimension; regulatory framework for starting a business (E1), entrepreneurial culture (E2), and attractiveness of the region and quality of infrastructure (E3). The third equation does this for access to finance; attitudes of investors and private financing (F1), legal framework supporting access to finance (F2), availability of funds from public sector (F3) and support from structural funds (F4). Equation 4 for the degree of collaboration and internationalisation dimension; general system linkages (C1), cross-sectoral linkages (C2), specialization (C3) and openness of the region (C4). Equation 5

for demand conditions; private demand (D1) and public demand (D2). Finally, equation 6 for the sub-dimensions to entrepreneurial conditions; regulatory framework for starting a business (E1), entrepreneurial culture (E2) and attractiveness of the region and quality of infrastructure (E3).

The same control variables were included in this equation. Furthermore I control for the four remaining dimensions of which key aspects are not included in the equation. It is important to note that this step is purely additional to the conceptual model and hypotheses. Insights may provide policy-makers with a comparative tool to develop more targeted and evidence based policy measures.

Equation 2:

$$NCO = \beta_0 + \beta_1 K1 + \beta_2 K2 + \beta_3 K3 + \beta_4 \ln(F) + \beta_5 \ln(C) + \beta_6 \ln(D) + \beta_7 \ln(E) + \beta_8 \ln(GDP\ Per\ Capita) + \beta_9 \ln(Employee) + \beta_{10} EmployeeCompensation + \beta_{11} \ln(CoporateTax) + \beta_{12} \ln(QualityOfGovernance) + \beta_{13} \ln(Access) + \varepsilon$$

Equation 3:

$$NCO = \beta_0 + \beta_1 F1 + \beta_2 F2 + \beta_3 F3 + \beta_4 F4 + \beta_5 \ln(K) + \beta_6 \ln(C) + \beta_7 \ln(D) + \beta_8 \ln(E) + \beta_9 \ln(GDP\ Per\ Capita) + \beta_{10} \ln(Employee) + \beta_{11} EmployeeCompensation + \beta_{12} \ln(CoporateTax) + \beta_{13} \ln(QualityOfGovernance) + \beta_{14} \ln(Access) + \varepsilon$$

Equation 4:

$$NCO = \beta_0 + \beta_1 C1 + \beta_2 C2 + \beta_3 C3 + \beta_4 C4 + \beta_5 \ln(K) + \beta_6 \ln(F) + \beta_7 \ln(D) + \beta_8 \ln(E) + \beta_9 \ln(GDP\ Per\ Capita) + \beta_{10} \ln(Employee) + \beta_{11} EmployeeCompensation + \beta_{12} \ln(CoporateTax) + \beta_{13} \ln(QualityOfGovernance) + \beta_{14} \ln(Access) + \varepsilon NCO = \beta_0 + \beta_1 D1 + \beta_2 D2 + \beta_3 QG + \beta_4 Cluster + \beta_5 Performance + \beta_6 Behaviour + \varepsilon$$

Equation 5:

$$NCO = \beta_0 + \beta_1 D1 + \beta_2 D2 + \beta_3 \ln(K) + \beta_4 \ln(F) + \beta_5 \ln(C) + \beta_6 \ln(E) + \beta_7 \ln(GDP\ Per\ Capita) + \beta_8 \ln(Employee) + \beta_9 EmployeeCompensation + \beta_{10} \ln(CoporateTax) + \beta_{11} \ln(QualityOfGovernance) + \beta_{12} \ln(Access) + \varepsilon$$

Equation 6:

$$NCO = \beta_0 + \beta_1 E1 + \beta_2 E2 + \beta_3 E3 + \beta_4 \ln(K) + \beta_5 \ln(F) + \beta_6 \ln(C) + \beta_7 \ln(D) + \beta_8 \ln(GDP\ Per\ Capita) + \beta_9 \ln(Employee) + \beta_{10} EmployeeCompensation + \beta_{11} \ln(CoporateTax) + \beta_{12} \ln(QualityOfGovernance) + \beta_{13} \ln(Access) + \varepsilon$$

Chapter 4. Results and Discussion

In the fourth chapter I will first present the regression results for the conceptual model. These results will indicate which dimensions are statically significant regional determinants to justify the regional variation in the number of cluster organizations across Europe. Regarding the broader perspective, tables 5-9 present the results from equations 2-6. The regressions test the correlation of the 16 sub-dimensions. Furthermore, the last section of this chapter tests for the robustness of the findings after correcting for possible complications as a result of matching the datasets.

4.1. Control Variables

Regarding the regional characteristics which are controlled for, results indicate that the development of cluster organizations in the sample size tends to be influenced by the number of employees in a cluster and their level of compensation. A regression with only control variables is shown in column (1). Six control variables were included of which only two were significant at a 5 percent significance level. The number of employees working in a cluster in each region and the employee compensation in a cluster are both statistically significant and both have a positive coefficient. When looking at the marginal effects, if the number of employees working in a cluster increases by 1%, I expect the number of cluster organizations to increase by 0.391 percentage points. Similarly, if employee compensation in a region increases by 1% I expect the number of cluster organizations to increase by 0.00003 percentage points. Most notably, the quality of governance and a region's GDP per capita are statistically insignificant.

4.2. Regional Determinant

The negative binomial regression results reported in Table 4, column 2 tests the significance of the five key dimensions which make up my conceptual model. This model in turn also tests the hypotheses. The variables tested in table 4 column 2 were taken from equation 1 in the previous chapter. In contrary to expectations, the coefficients of the collaboration and internationalization dimension are positive, however, this statistic is not significant so it may be omitted from further discussions. Access to finance has the expected sign but is also statistically insignificant in this model. More important are the statistically significant coefficients of the knowledge basis and skills dimension and the demand and entrepreneurial conditions dimensions (significant at the 5, 1 and 10 percentage significance levels, respectively). Moreover, the sign of the coefficient for all three dimensions are as expected. The coefficients suggest that from a 1% increase in a region's quality of the knowledge basis and skill we expect the number of cluster organizations hosted in the region to increase by 1.476 percentage points.

When interpreting the quality of entrepreneurial and demand conditions, a 1 percent increase will result in the number of cluster organizations to decreasing by 0.889 and 0.800 percentage points (respectively). As such, an increase in a region's entrepreneurial and demand conditions decreases the observed number of cluster organizations hosted in the region whilst the quality of a region's knowledge basis and skills results in the opposite. An interesting observation in column 2 is that the number of employees employed in a cluster is still statistically significant and has a weak but positive coefficient whilst employee compensation is now statistically insignificant. The coefficients suggest that 1% increase in the number of employees working in a cluster leads to 0.366 percentage point increase in the number of cluster organizations.

Table 4: Regression results for the Conceptual Model

	(1)	(2)
VARIABLES	Control Variables	Conceptual Model
ln(Entrepreneurial Dimension Conditions)		-0.889*
		(0.508)
ln(Collaboration Dimension)		0.153
		(0.375)
ln(Knowledge Dimension)		1.476**
		(0.597)
ln(Demand Conditions Dimension)		-0.800***
		(0.277)
ln(Access to Finance Dimension)		-0.0322
		(0.380)
ln(GDP per capita)	-0.562	-0.266
	(0.422)	(0.434)
ln(Number of Employees)	0.391***	0.366***
	(0.0493)	(0.0477)
Employee Compensation	3.38e-05***	4.45e-06
	(1.05e-05)	(1.23e-05)
ln(Corporate Tax)	0.622	0.551
	(0.470)	(0.609)
ln(Quality of Governance)	0.0266	0.0732
	(0.185)	(0.169)
ln(Regional Accessibility)	-0.208	-0.161
	(0.309)	(0.274)
Observations	208	208

Presented coefficients are estimated marginal effects.
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The marginal effects discussed above imply that the availability of knowledge and skills, entrepreneurial conditions and demand side conditions affect the number of cluster organizations in a region. Furthermore, all three are in line with other literature. The availability of knowledge and skills in a

region is positively correlated to the number of cluster organizations hosted in a region. Conversely, the level of the demand, including both private and public demand, within a region is negatively related to the number of cluster organizations the region hosts and so are entrepreneurial conditions of the institutional framework for doing business in the region. As there is no prior research investigating whether there are determinants to identify factors to justify the regional variation in the number of cluster organizations hosted by regions, this research is an explanatory one. This research focuses on identifying these determinants, below I present my findings on the sub-dimensions.

4.3. Clusters of Policies

Regarding the broader perspective, tables 5 presents the results for the negative binomial regressions which we get from equations 2-6. The regressions test the correlation of the 16 sub-dimensions, which make up the five key dimensions of my conceptual model.

Statistical Results Hypothesis 1

Column 2 shows the regression testing the significance of the three key aspects of the Knowledge Basis and Skills dimension. Though the knowledge basis and skills dimension is significant and in accordance to expectations, only two of the three indicators are significant. The quality of human resources and the availability of vocational and lifelong learning are both statistically and have a positive coefficient.

From the observed coefficients we expect that a 1% increase in the quality of human resources will result in 0.828 percentage point more cluster organizations in the region. Furthermore, a 1% increase in the availability of vocational and lifelong learning result in 0.765 percentage points more cluster organizations in the region. Of the original control variables only the number of employees is statistically significant and has a weak but positive coefficient whilst. We expect to see 0.341 percentage points more cluster organizations in a region if there is a 1% increase in the number of employees that work in a cluster in that region. Furthermore, only two omitted dimensions from the conceptual model, are significant. As in the table 4 the entrepreneurial and demand conditions dimensions are now also statistically significant. When interpreting the coefficients we expect to see 1.074 percentage and 0.674 percentage point (respectively) decrease in the number of cluster organizations in a region if the quality of demand conditions and entrepreneurial conditions increase by 1%.

In line with hypothesis 1, these results indicate that the number of cluster organizations is more likely to increase as the quality of the knowledge basis and skills within a region increases. Furthermore, the results above indicate that two indicators of the knowledge dimension are statistically significant.

Table 5: Quality of the knowledge basis and skills within a region

VARIABLES	(2) Knowledge	(3) Finance	(4) Collaboration	(5) Demand	(6) Entrepreneurship
ln(Knowledge Dimension)		1.162***	1.289**	1.425**	1.688***
		(0.425)	(0.513)	(0.617)	(0.497)
ln(Access to Finance Dimension)	0.100		0.262	-0.0872	0.221
	(0.393)		(0.325)	(0.378)	(0.398)
ln(Collaboration Dimension)	-0.135	0.619		0.178	-0.418
	(0.387)	(0.390)		(0.411)	(0.387)
ln(Demand Conditions Dimension)	-0.674**	-0.768***	-0.919***		-0.413
	(0.282)	(0.275)	(0.255)		(0.302)
ln(Entrepreneurial Dimension Conditions)	-1.074**	-1.509***	-0.649	-0.900*	
	(0.517)	(0.542)	(0.487)	(0.502)	
ln(Quality of Human Resources)	0.828***				
	(0.267)				
ln(Availability of Training and Learning)	0.765**				
	(0.330)				
ln(Availability and Quality of Skills)	0.0549				
	(0.186)				
ln(Attitude of regional investors and private finance)		-0.0819			
		(0.229)			
ln(Legal Framework for Finance)		0.470**			
		(0.192)			
ln(Availability Public Funds)		-0.251***			
		(0.0719)			
Support from Structural Funds		-0.178			
		(0.529)			
ln(Degree of General System Linkages)			-0.547***		
			(0.200)		
ln(Degree of Cross-Sectoral Linkages)			-0.0836		
			(0.210)		
ln(Degree of Specialization)			-0.326		
			(0.325)		
ln(Openness of the Region)			1.039***		
			(0.249)		
Private Demand Conditions				-1.187	
				(1.259)	
Public Demand Conditions				-0.901*	
				(0.521)	
ln(New Business Regulatory Framework)					-2.554***
					(0.657)
Quality of Entrepreneurial Culture					2.545***
					(0.935)
Regional attractiveness & infrastructure					-0.183
					(0.594)
ln(GDP per Capita)	-0.307	-0.663*	-0.0774	-0.244	-0.0973
	(0.444)	(0.390)	(0.371)	(0.416)	(0.374)
ln(Number of Employees)	0.341***	0.365***	0.360***	0.364***	0.299***
	(0.0511)	(0.0530)	(0.0427)	(0.0499)	(0.0492)
Employee Compensation	5.28e-06	2.39e-05**	-1.44e-05	5.76e-06	-1.55e-05
	(1.22e-05)	(1.16e-05)	(1.17e-05)	(1.20e-05)	(1.27e-05)
ln(Corporate Tax)	0.455	0.611	0.625	0.506	0.595
	(0.547)	(0.432)	(0.501)	(0.619)	(0.500)
ln(Quality of Governance)	0.0767	0.190	-0.0186	0.0595	0.180
	(0.169)	(0.165)	(0.162)	(0.165)	(0.165)
ln(Regional Accessibility)	-0.134	-0.219	-0.290	-0.179	0.237
	(0.251)	(0.223)	(0.280)	(0.273)	(0.332)
Observations	208	208	208	208	208

Presented coefficients are estimated marginal effects.
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Statistical Results Hypothesis 2

The third column presents the regression testing the significance of the four key aspects of the Access to finance dimension. Here the results do not indicate a significant correlation between the number of cluster organizations in a region and the availability and accessibility to finance within a region. Therefore the second hypothesis is rejected. The coefficient for legal framework, which plays a supporting role in access to finance, is statistically significant and positive whilst the coefficient for the availability of funds from the private sector is also statistically significant but negative. This whilst the coefficient for the access to finance dimension was not statistically significant in table 4.

When interpreting the coefficients of the dimensions indicators, in column 3, I expect that a 1% increase in the quality of the legal framework supporting access to finance leads to 0.470 percentage points more cluster organizations hosted by a region. Conversely a 1% increase in the availability of funds from the public sectors leads to 0.251 percentage points fewer cluster organizations in the region. When assessing the statistical significance of the control variables we see that once again both the number of employees working in clusters and their compensation in a region are significant positively correlated to the number of cluster organizations in a region. Furthermore, the GDP per Capita of the region is also significant in this model. After interpreting the coefficient I would expect the number of cluster organizations to decrease by 0.663 percentage points if the GDP per Capita of the region would increase by 1%. Also similar to the model testing the conceptual framework is that both the coefficients of the knowledge basis and skills dimension and the demand and entrepreneurial conditions dimensions are statistically significant. Interpreting the marginal effects, a 1% increase in the quality of the knowledge basis and skills of a region I expect the number of cluster organizations to increase by 1.162 percentage points. Furthermore, I expect a 1% increase in the quality of demand and entrepreneurial conditions lead to 0.769 and 1.509 percentage points (respectively) fewer cluster organizations region.

Statistical Results Hypothesis 3

The collaboration and internationalisation dimension is presented in the fourth. The coefficient for the degree of general systems linkages and openness of a region are statistically significant even though the coefficient for the Collaboration and Internationalisation dimension was not statistically significant. From observing the coefficients I expect that a 1% decrease in the degree of general systems linkages to result in 0.547 percentage points fewer cluster organizations in a region. Furthermore, a 1% increase in the openness of a regions would be expected to result in 1.029 percentage points more cluster organizations in the region. Once again the number of employees working in clusters is statistically

significant and its coefficient is positive. Moreover the coefficients of the knowledge basis and skills and the demand conditions dimensions are still statistically significant. A 1% increase in the quality of a region's knowledge basis and skills would be expected to increase the number of cluster organizations it hosts by 1.29 percentage points. Conversely, a similar change in the quality of demand conditions will lead to 0.919 percentage points fewer cluster organizations.

Once more the results above do not indicate a significant correlation between the tested dimension and the number of cluster organizations. Results indicate that degree of collaboration & internationalisation of knowledge flows from cluster system actors in a region are not significantly related to the number of cluster organizations in a region, rejecting the third hypothesis.

Statistical Results Hypothesis 4

Column 5 presents the regression testing the significance of the two key aspects of the Demand Conditions dimension. The coefficient for public finds (Public Demand Conditions) is statistically significant and positive whilst the coefficient for private funds (Private Demand Conditions) is statistically insignificant even though the dimension for demand conditions was statistically significant. When interpreting the coefficients I expect that a point increase in public demand conditions will lead to 0.901 percentage points fewer cluster organizations in a region. Of the control variables included in table 4, the number of employees working in clusters is statistically significant and based on the coefficient I expect the number of cluster organizations to increase as they are positively correlated. Moreover, the coefficients of the knowledge basis and skills and entrepreneurial conditions dimensions are statistically significant and in line with the results in table 4. Interpreting the marginal effects, a 1% increase in the quality of a region's knowledge basis and skills would lead to 1.425 percentage points more cluster organizations whilst a similar change in the entrepreneurial conditions would decrease lead to 0.0900 percentage points fewer cluster organizations.

In line with the fourth hypothesis, the results in the second column above indicate that the number of cluster organizations is more likely to increase as the demand conditions of the region improve. Therefore I do not reject the fourth hypothesis. However, the third column however indicates that only the public demand conditions are statistically significant whilst the private demand conditions are not.

Statistical Results Hypothesis 5

The sixth column presents the regression testing the significance of the three key aspects of the Entrepreneurial Conditions dimension. The coefficient for the quality of the regulatory framework for

starting a business in a region is statistically significant and negative whilst the coefficient for the quality of entrepreneurial culture is also statistically significant but positive. The coefficients point out that 1% increase in the quality of the regulatory framework for starting a business in a region should lead to 2.554 percentage points fewer cluster organizations in the region. Conversely, I expect that a point increase in the region's quality of entrepreneurial culture would result in 2.545 percentage point increase in the number of cluster organizations hosted by the region. Furthermore, of the control variables in the model only the number of employees working in clusters and the coefficients for the knowledge basis and skills dimensions are statistically significant. Interpreting their coefficients would imply that a 1% increase in the number of employees working in clusters in a region is positively correlated to the number of cluster organizations hosted by the region. Additionally, I expect that a 1% increase in the quality of a region's knowledge basis will lead to 1.688 percentage point increase in the number of cluster organizations in a region.

From this follows that the outcomes of the regression portrayed in the tables above supports only hypothesis 1, hypothesis 4 and hypothesis 5. The positive sign of the knowledge dimension coefficient in column 4 sis straight forward and in line with theory and expectations. I cannot reject that the quality of knowledge and skills within a region is positively related to the number of cluster organizations the regions hosts. Furthermore, the negative signs of the entrepreneurial conditions and demand conditions dimensions are also in line with theory and expectations. I cannot reject that entrepreneurial conditions of the institutional framework for doing business in the region or the level of the demand, including both private and public demand, within a region are negatively related to the number of cluster organizations the region hosts. Moreover, hypotheses 2 and 3 are rejected which implies that neither the availability and access to finance within a region nor the degree of collaboration & internationalisation of knowledge flows from cluster system actors could be considered regional indicators for the variance in the number of cluster organizations across NUTS-2 regions in the Life Sciences Industry across Europe.

In conclusion, the results from my research indicate that cluster policies do work dynamically and that there are certain sub-dimensions and dimensions which do justify the regional variation in the number of cluster organizations hosted in a region. Whether increasing policy incentives focused on these indicators consequently lead to more cluster organizations is not yet proven. In the last chapter I will elaborate on the implications and limitations of my research.

4.4. Robustness

To ensure the reliability of the results which are the foundation for the remaining chapters, I have incorporated a robustness check. I will exclude Belgium, Finland, Germany, and the United Kingdom from the data and run similar regressions as above. The reason for doing so is to test for the impact of matching problems. The data retrieved from the European Cluster Observatory only covered Belgium, Germany and the United Kingdom at a NUTS-1 level. Furthermore, NUTS-2 classifications of Finland changed from in 2010. Count data on the number of cluster organizations in a region obtained from survey data (Burger et al., 2015) classified Finland's NUTS-2 regions based on the pre-2010 NUTS-2 classification whilst the European Cluster observatory classified Finland's NUTS-2 regions using post-2020 NUTS-2 classifications.

Following the same set-up as in table 5, table 6 is relatively recognisable. Additionally, the first column of table 6 shows the results from conceptual mode where the same six control variables were included. Noteworthy is that there are now only 113 observations. That is low when taking into account the high number of independent variables. When interpreting coefficients, it is important to keep in mind that a few outliers may significantly distort data, especially with the low level of observations. Furthermore, it is questionable how much variation even could exist with this low level of observations. Hence, interpret the results from the robustness check with caution as they may not be reliable or representative of the real world.

After interpreting the coefficients in the column I expect a 1% increase in the number of employees working in a cluster to lead to 0.251 percentage points more number of cluster organizations hosted in that region. In contrary to expectations and the results in table 4, the coefficients of the Collaboration and Internationalization dimension is positive and statistically significant. The coefficient implies that a 1% increase in the degree of collaboration and internationalization across a region leads to 1.978 percentage point increase in the number of cluster organizations in the region. Furthermore, as in table 4, the statistically significant coefficients of the knowledge basis and skills dimension and the demand conditions dimensions are in line with expectations. The coefficients suggest if a 1% increase in a region's quality of the knowledge basis I can expect the number of cluster organizations hosted in the region to increase by 1.508 percentage points, whilst after a similar change in the quality of demand conditions I can expect number of cluster organizations hosted in the region to decrease by -1.311 percentage points. Furthermore, as in tables 4 and 5, the control variable, number of employees, is still statistically significant and has a weak but positive coefficient which suggests that if I observe a 1%

increase in the number of employees working in clusters in a region, I can expect the number of cluster organizations to increase by 0.251 percentage points.

Column 2-6 present only the significant results for the negative binomial model which we get from equations 2-6 after Finland, Belgium, Germany and the UK have been omitted from the dataset. Column (2) presents the regression testing the significance of the three key aspects of the Knowledge Basis and Skills dimension, column (3) the four the key aspects of the Access to finance dimension, column (4) presents four key aspects of the Collaboration and Internationalisation dimension, column (5) the two key aspects of the Demand Conditions dimension and finally column (6) presents the regression testing the significance of the three key aspects of the Entrepreneurial Conditions dimension.

Overall, similar results are obtained after omitting data to control for a possible mismatch in the data, although the only major difference with previous analysis in table 5 is the degree of collaboration and internationalisation dimension now significantly affects the number of cluster organizations hosted in a region whilst entrepreneurial conditions do not. Furthermore, there are no sub dimensions which were not statistically significant before which now are statistically significant. On the contrary, the availability of vocational and lifelong training and the degree of general systems linkages, which were significant in tables 5 are no longer significant. The same applies for the quality of a region's legal framework for finance and the availability of public funds.

Noteworthy though is that there is a significant change in the coefficients of statistically significant variables compared to table 5. In the light of the low level of observations, mentioned on the previous page, the results must be interpreted with caution. These are mainly indicative and most weight should be attached to the original results as displayed in table 5, where hypotheses 1, 4 and 5 are not rejected.

Table 6: Robustness Check testing 17 Sub-Dimensions

VARIABLES	(1) Conceptual Model	(2) Knowledge	(3) Finance	(4) Collaboration	(5) Demand	(6) Entrepreneurship
ln(Knowledge Dimension)	1.508**		1.017	1.618**	1.542*	2.030***
	(0.726)		(0.626)	(0.684)	(0.791)	(0.676)
ln(Access to Finance Dimension)	0.0503	0.508		0.188	-0.0352	0.0418
	(0.442)	(0.452)		(0.400)	(0.447)	(0.441)
ln(Collaboration Dimension)	1.978***	1.716***	1.710***		1.933***	0.855
	(0.617)	(0.550)	(0.557)		(0.632)	(0.627)
ln(Demand Conditions Dimension)	-1.311***	-1.175***	-1.501***	-1.276***		-0.823**
	(0.310)	(0.352)	(0.358)	(0.313)		(0.383)
ln(Entrepreneurial Dimension Conditions)	-0.993	-0.440	-0.907	-0.737	-0.939	
	(0.698)	(0.604)	(0.719)	(0.610)	(0.709)	
ln(Quality of Human Resources)		1.039***				
		(0.294)				
ln(Availability of Training and Learning)		0.0530				
		(0.420)				
ln(Availability and Quality of Skills)		0.0102				
		(0.188)				
ln(Attitude of regional investors and private finance)			-0.112			
			(0.252)			
ln(Legal Framework for Finance)			0.751***			
			(0.233)			
ln(Availability Public Funds)			-0.369***			
			(0.110)			
Support from Structural Funds			-0.677			
			(0.706)			
ln(Degree of General System Linkages)				-0.282		
				(0.234)		
ln(Degree of Cross-Sectoral Linkages)				-0.0896		
				(0.241)		
ln(Degree of Specialization)				0.198		
				(0.461)		
ln(Openness of the Region)				1.338***		
				(0.310)		
Private Demand Conditions					-1.343	
					(1.732)	
Public Demand Conditions					-1.780***	
					(0.650)	
ln(New Business Regulatory Framework)						-2.327***
						(0.724)
Quality of Entrepreneurial Culture						1.919
						(1.178)
Regional attractiveness & infrastructure						0.502
						(1.011)
ln(GDP per Capita)	0.0307	0.220	-0.587	0.0163	-0.0150	-0.0480
	(0.611)	(0.521)	(0.559)	(0.534)	(0.646)	(0.515)
ln(Number of Employees)	0.251***	0.223***	0.342***	0.288***	0.241***	0.182**
	(0.0579)	(0.0584)	(0.0660)	(0.0568)	(0.0749)	(0.0707)
Employee Compensation	-3.43e-05	-5.08e-05**	-1.32e-05	-4.16e-05*	-3.05e-05	-4.02e-05*
	(2.24e-05)	(2.24e-05)	(2.19e-05)	(2.16e-05)	(2.17e-05)	(2.07e-05)
ln(Corporate Tax)	1.153**	0.890*	1.408***	1.363***	1.131*	0.963*
	(0.582)	(0.512)	(0.537)	(0.508)	(0.591)	(0.494)
ln(Quality of Governance)	0.120	0.208	0.294	0.0492	0.0933	0.233
	(0.195)	(0.206)	(0.214)	(0.192)	(0.192)	(0.197)
ln(Regional Accessibility)	0.0603	-0.0400	-0.0234	-0.203	0.0256	0.234
	(0.318)	(0.307)	(0.279)	(0.321)	(0.312)	(0.375)
Observations	113	113	113	113	113	113

Presented coefficients are estimated marginal effects.
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Chapter 5. Conclusion

The strategic and economic importance of the role of cluster organizations is growing. Clustering enables the spill-over of knowledge and facilitates co-operation as well as competition and affects competition in three broad ways: they increase the productivity of firms based within the spatial proximity of the cluster; drive the direction and pace of innovation, which underpins future productivity growth; and stimulate the formation of new businesses, which expands and strengthens the cluster itself (Porter, 1998c). Clusters play a significant role in raising the competitive advantages and innovative strengths of regional economies and firms (Ketels et al., 2012; Sölvell and Williams, 2013), and are thus considered key factors for sustainable economic growth. Although cluster policies vary considerably across regions and countries, most cluster programs within the European Union pay dedicated attention to the funding of cluster organizations (Lämmer-Gamp et al., 2012). Despite limited knowledge concerning the function and heterogeneous nature of cluster organizations (Lindqvist, 2009; Ebbekink and Lagendijk, 2013), cluster organizations are a crucial factor in regional policy-making and long-term economic development (Porter, 2000; Ketels et al., 2012). The main objective of this study is to empirically identify determinants justifying the regional variation in the number of cluster organizations hosted by regions across 15 EU-member states.

The number of cluster organizations in a region is not necessarily indicative of the quality of these cluster organizations or the funds that they have available to pursue their activities, it is indicative of how active a region is in promoting the development of a cluster (Burger et al., 2015). In my conceptual framework, like the national systems of innovation approach, I consider innovation is an interactive, non-linear process in which actors interact with a manifold of organizations (Lankhuizen and Woolthuis, 2003). These interactions are governed by institutions, such as cluster organizations that function as a facilitator of knowledge sharing (Lindqvist, 2009; Ketels et al., 2012; Laur et al., 2012) and initiates collaboration which determines the success of innovation (Freeman, 1987; Lundvall 1992; Nelson, 1993; Edquist, 1997).

The results, presented in the previous chapter identify regional determinants at a NUTS-2 level, can be summarized as follows. First, the quality of the knowledge basis and skills within a region is positively related to the number of cluster organizations the region hosts, highlighting the increasing importance of skills in a knowledge-based global economy. Second, high levels of demand are negatively related to the number of cluster organizations the region hosts. Corroborating that in regions where there is a high level of demand there is less need to stimulate coordinating, facilitating or lobbying activities. Finally,

entrepreneurial conditions of the institutional framework for doing business in the region are negatively related to the number of cluster organizations the region hosts. This indicates that a good business climate reduces the need for cluster organisations. However, results from the robustness test provide evidence that a mix of entrepreneurial attitudes, activities and aspirations and the relationship of these indicators and economic development is not as straight forward as anticipated. Moreover, neither the relationship between accessibility/availability of finance, nor the degree of collaboration/internationalisation of knowledge between cluster system actors could be proven and the number of cluster organizations hosted in a region could be justified.

Although there is a limited amount of literature, this research is a strong basis on which future research can explore the nature of cluster organisations. There are two significant limitations to this research which future research could focus on. First, findings are not generalizable as the research focuses on only the life sciences sector. Furthermore the matching problem discussed shows that the sample size is not waterproof. Future research could look into multiple sectors and should ensure that as much data as possible is collected at the same regional level. Second, my conceptual model focuses on key dimensions based on national systems of innovation approach. Results concerning the sub dimensions did however show that the mechanism behind the dimensions is a topic which should be explored further. Hence the recommendations for further research are twofold: investigate the dimensions from the conceptual model across other sectors as to make findings and the methodology generalizable, also, explore the sub-dimensions to gain further insights into the mechanisms behind the model.

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